HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

# 219A/B/C

## DIGITAL DELAY PLUG-IN UNITS

219A/B/C

## CERTIFICATION

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OPERATING AND SERVICING MANUALS

# MODELS 219A, 219B, 219C
## Plug-In Units for
## 218A Digital Delay Generator

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## GENERAL CONTENTS

MODEL 219A DUAL TRIGGER UNIT



MODEL 219B DUAL PULSE GENERATOR



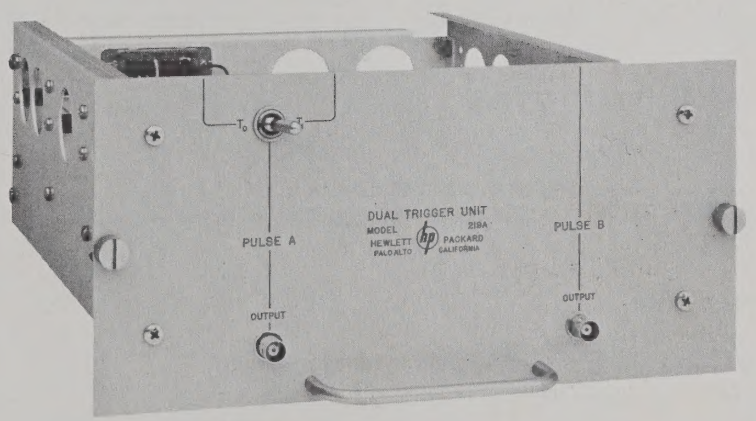
MODEL 219C PULSE DURATION GENERATOR

# OPERATING AND SERVICING MANUAL

219A

## MODEL 219A
## DUAL TRIGGER UNIT

SERIALS PREFIXED: 119-



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## SPECIFICATIONS (MODEL 219A)

When Plugged in Model 218A

| | |
|---|---|
| OUTPUT: | Two pulses, A and B, approximately 50 volts amplitude, 0.1 μsec rise time from 50 ohm source. |
| TIMING: | Pulse A at $T_0$ or $T_1$ as selected by a switch. Pulse B at $T_2$. |
| POLARITY: | Positive |
| POWER: | Supplied by ℌ Model 218A |
| WEIGHT: | Net approximately 4 lbs |

Power Requirements for Independent Operation

| | |
|---|---|
| INPUT: | Amplitude: 20 volts minimum, positive pulse.<br>Rise time: 0.1 μsec minimum. |
| POWER: | +180 volts, regulated, 1 ma. -200 volts, regulated, 10 ma. 6.3 volts, ac, 1.8 amperes. Connector mates with Amphenol "Blue Ribbon" connector #26-4200-16S. |

## CONTENTS

# SECTION I
# GENERAL INFORMATION

## 1-1 GENERAL

Model 219A is a plug-in accessory for the Model 218A Digital Delay Generator, providing the output pulses of the 218A. The 219A plug-in delivers two output pulses A and B. Both pulses have an amplitude of approximately 50 volts, a rise time of 0.1 μsec and are driven from a 50 ohm source. The leading edge of pulse A occurs at $T_0$ or $T_1$ as selected by a switch. The leading edge of pulse B occurs at $T_2$.

The Model 219A can also be operated as separate trigger pulse generator, see paragraph 1-3.

## 1-2 CONNECTIONS TO MODEL 218A

All connections of the Model 219A Dual Trigger Unit to the Model 218A Digital Delay Generator are made through a plug-jack combination by inserting the 219A into the opening provided in the 218A. Operating voltages for the 219A are furnished by the 218A.

## 1-3 219A AS SEPARATE TRIGGER PULSE GENERATOR

The 219A Dual Trigger Unit can be operated as individual high power trigger pulse generator, by supplying externally trigger pulses and the necessary supply voltages from standard laboratory power supplies. The current requirements of the various supply voltages are listed in the Specifications. Figure 1-1 shows the external connections to the 16-pin connector.

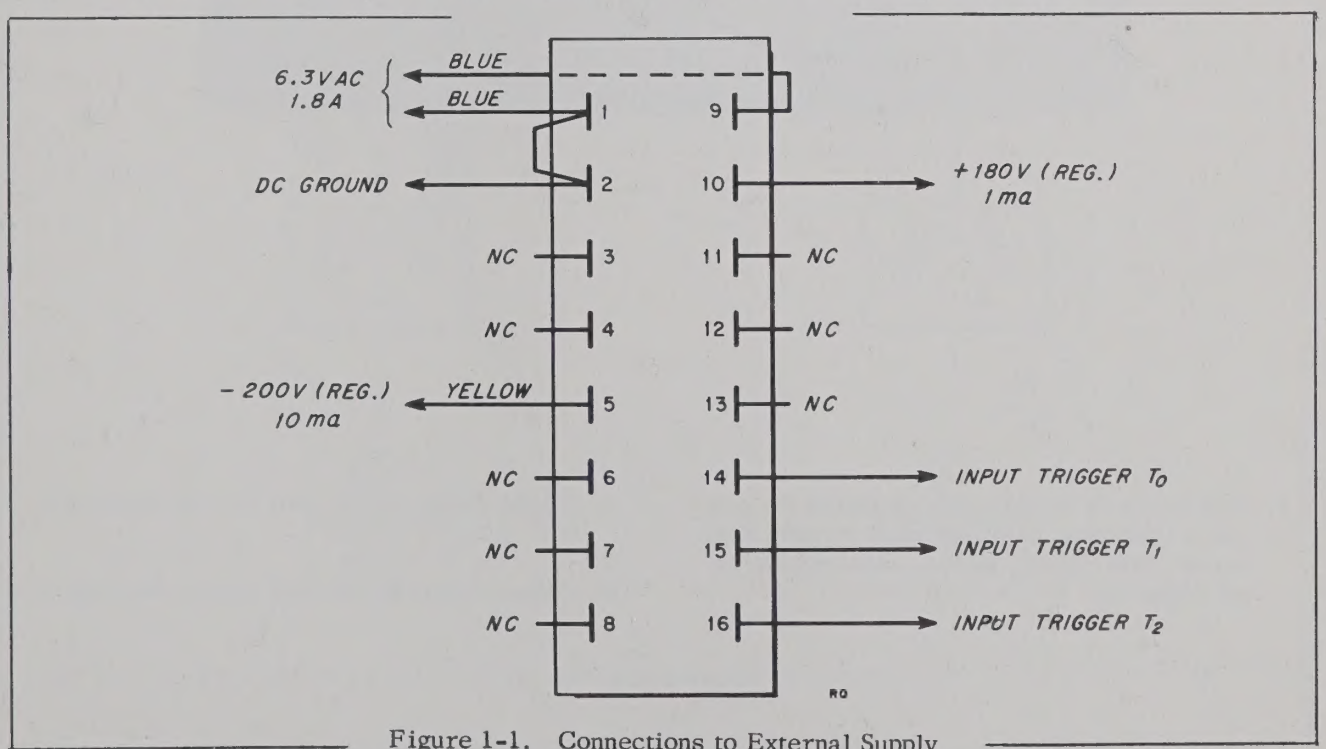
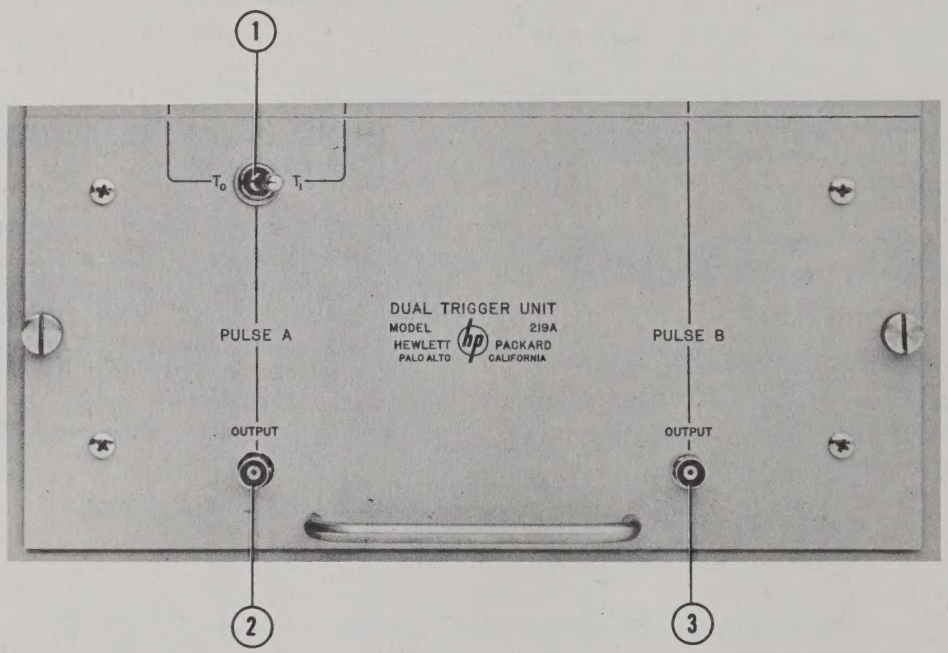



Figure 1-1. Connections to External Supply

## 219A OPERATING PROCEDURE




1. Select time of leading edge of Output Pulse A (when operating as independent trigger generator, this switch selects between two input triggers).
2. Output Pulse A, 50 ohm source impedance.
3. Output Pulse B, 50 ohm source impedance.

Figure 2-1.

# SECTION II
# OPERATION

## 2-1 GENERAL

The 219A Dual Trigger Unit operates in conjunction with the 218A Digital Delay Generator. Refer to Figure 2-1 for operation procedure of 219A Plug-In Unit.

## 2-2 APPLICATIONS

Paragraph 2-6 of the Model 218A Operating and Servicing Manual lists a number of applications of the 219A plug-in unit in conjunction with the Model 218A.

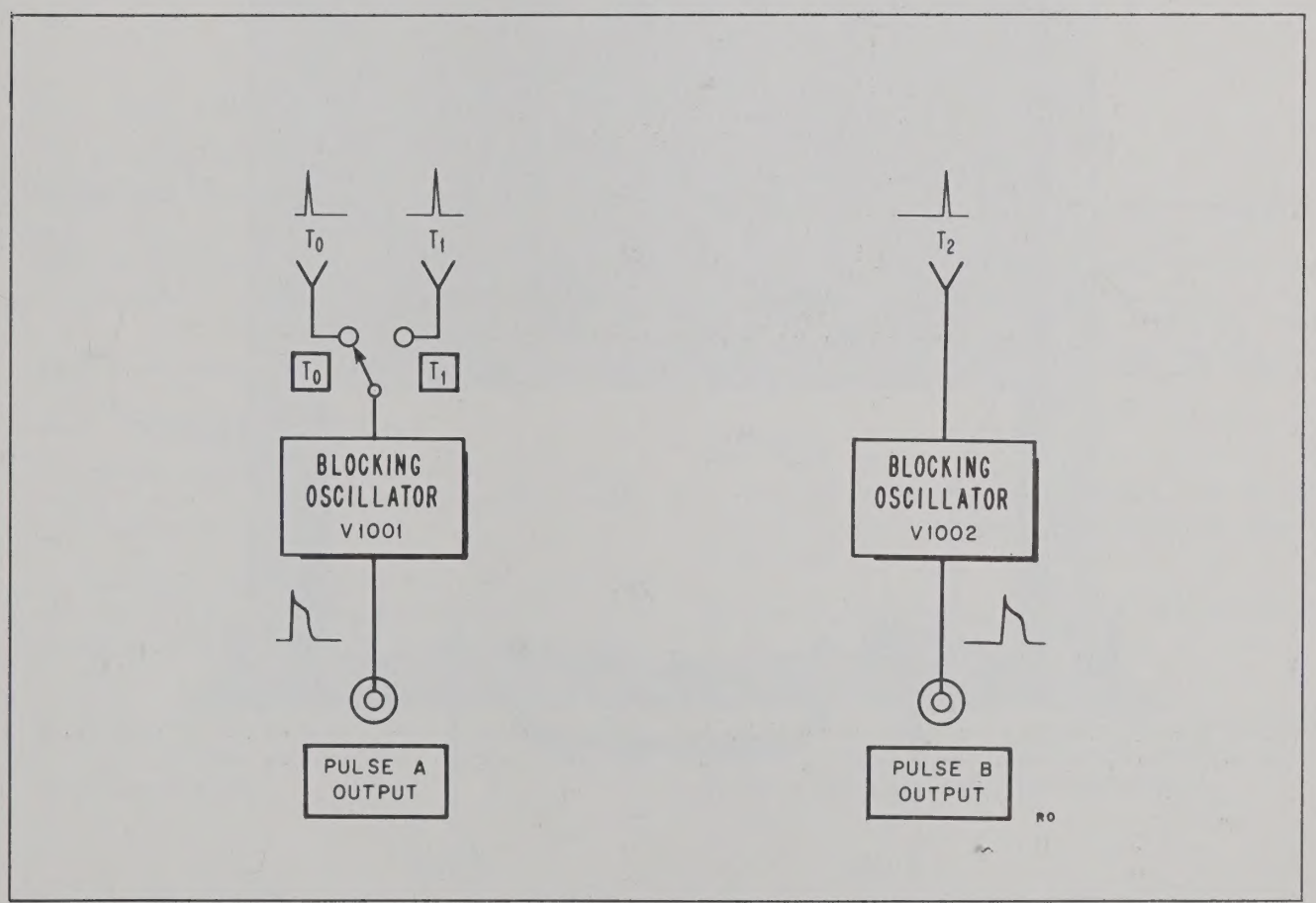



Figure 2-2. Block Diagram of Model 219A

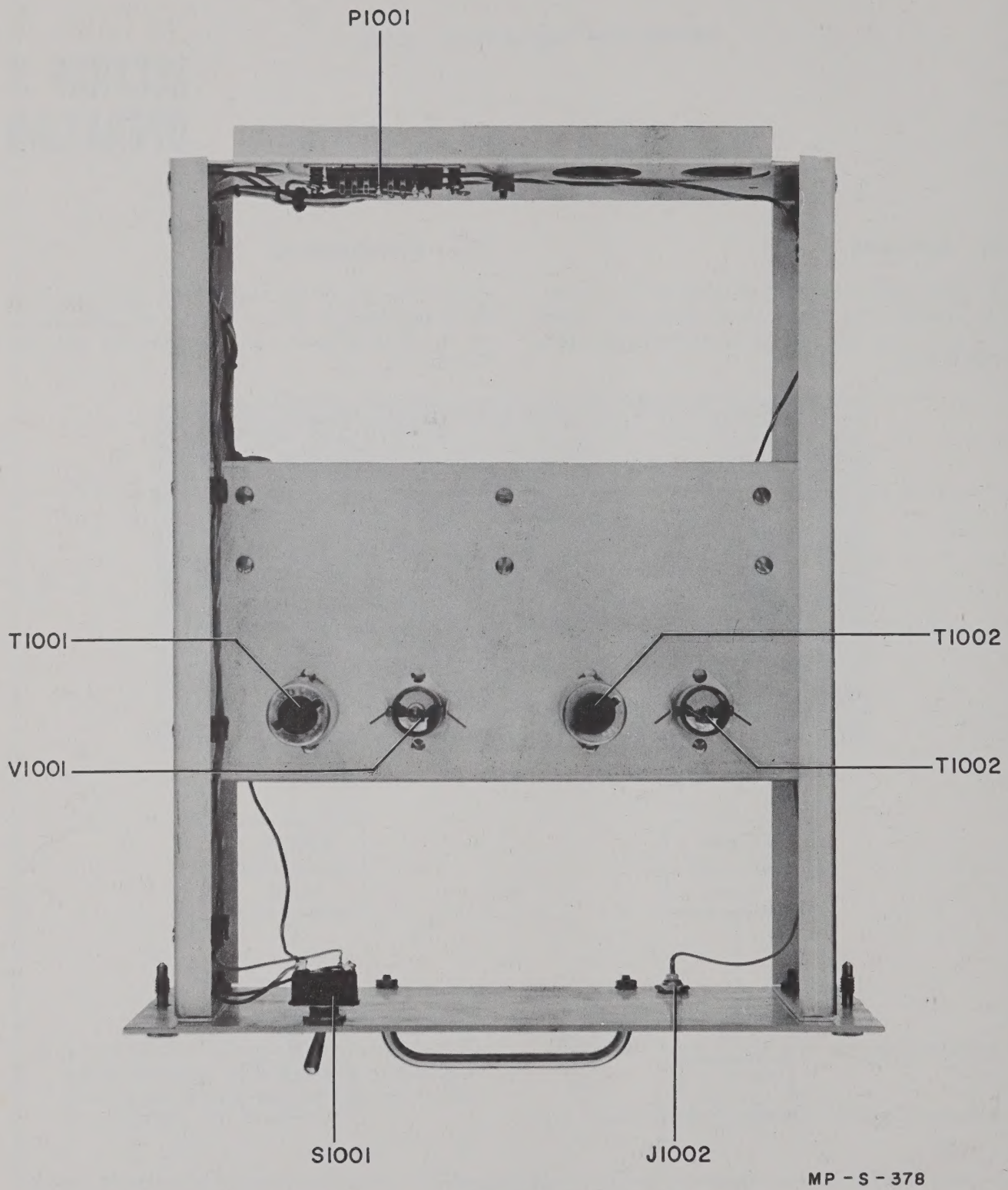



Figure 3-1. Top View of Model 219A

# SECTION III
# MAINTENANCE

## 3-1 CIRCUIT DESCRIPTION

The Model 219A Dual Trigger consists of two identical blocking oscillator sections. The following description refers to the block diagram, Figure 2-2, and to circuit diagram, Figure 3-3.

Blocking oscillator V1001 generating pulse A is triggered at $T_0$ or $T_1$. The incoming trigger pulse is amplified, inverted and plate coupled to the blocking oscillator.

## 3-2 TEST EQUIPMENT

The following test equipment is needed to service the Model 219A:

High Frequency Oscilloscope, such as ℌ Model 150A or equivalent, with Dual Trace plug-in unit Model 151A.

## 3-3 TROUBLE SHOOTING

The proper operation condition of the 219A can be checked with the oscilloscope. Possible trouble symptoms are:

1) Poor Rise Time--Weak tubes cause poor rise time and reduce amplitude of the output pulse. See paragraph 3-4 for checking pulse characteristics of tubes.

2) Backswing of Output Pulse--Defective diode CR1001 (CR1002 respectively) causes backswing of the output pulse.

Diode Replacement

Replacement of diodes is not critical. Observe polarity and correct diode type when making a replacement. The diodes are color coded and identified as shown:


## 3-4 CHECKING TUBE PULSE CHARACTERISTICS

The following describes a convenient method to check tube pulse characteristics under dynamic operating conditions. The test compares two output voltages measured at the output jack (front panel) of the 219A. The first reading is taken with the output open ended, the second reading with the output terminated in 50 ohms.

Procedure:

1) Observe output trigger pulse A with oscilloscope (use AC-21A/C Low Capacity Probe) with output open ended.

2) Terminate PULSE OUTPUT A with 50 ohms.

3) Observe output trigger pulse A.

Check: Dynamic pulse characteristic is good, if pulse amplitude of terminated output is 40% or more of pulse amplitude with output open ended.

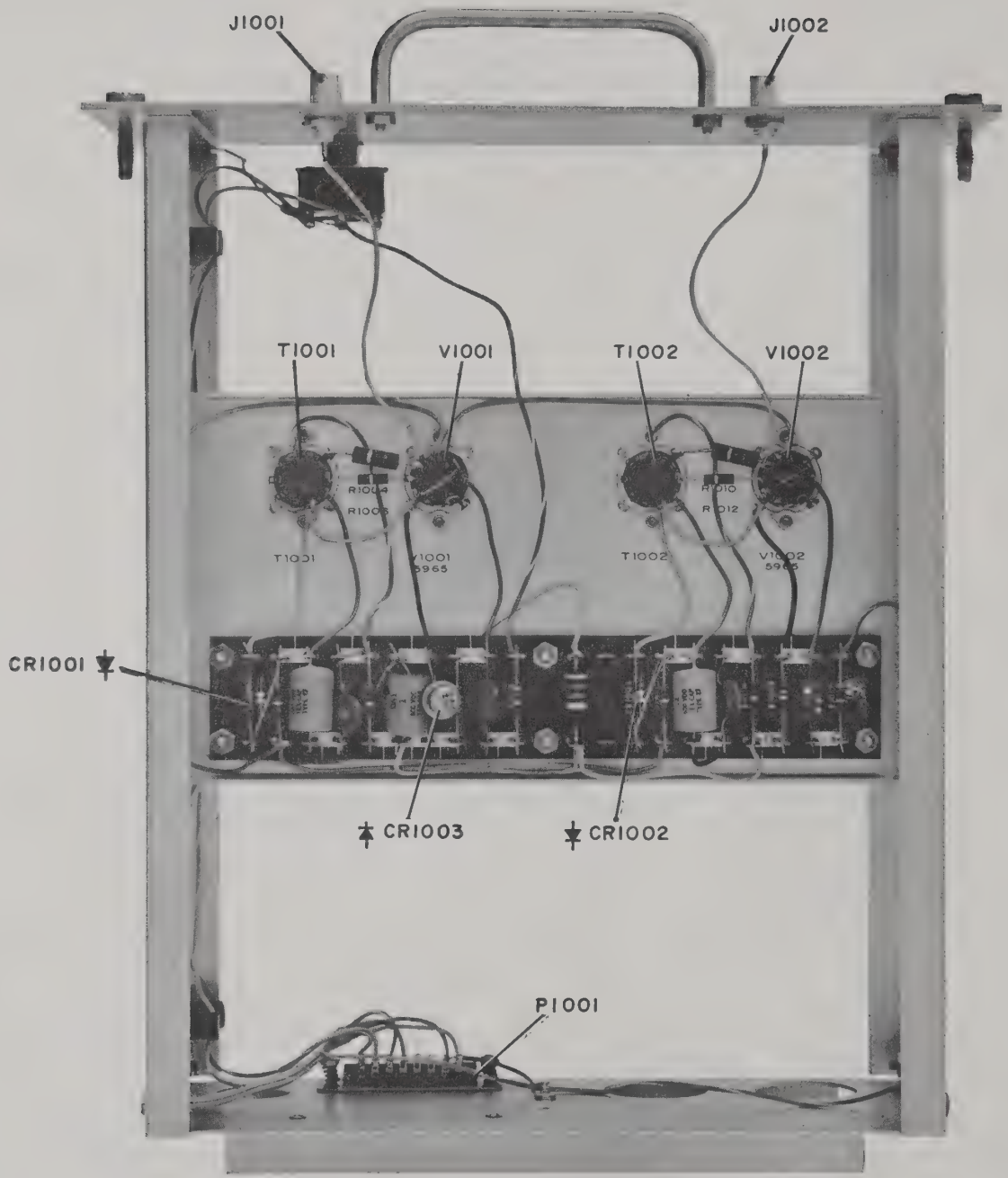
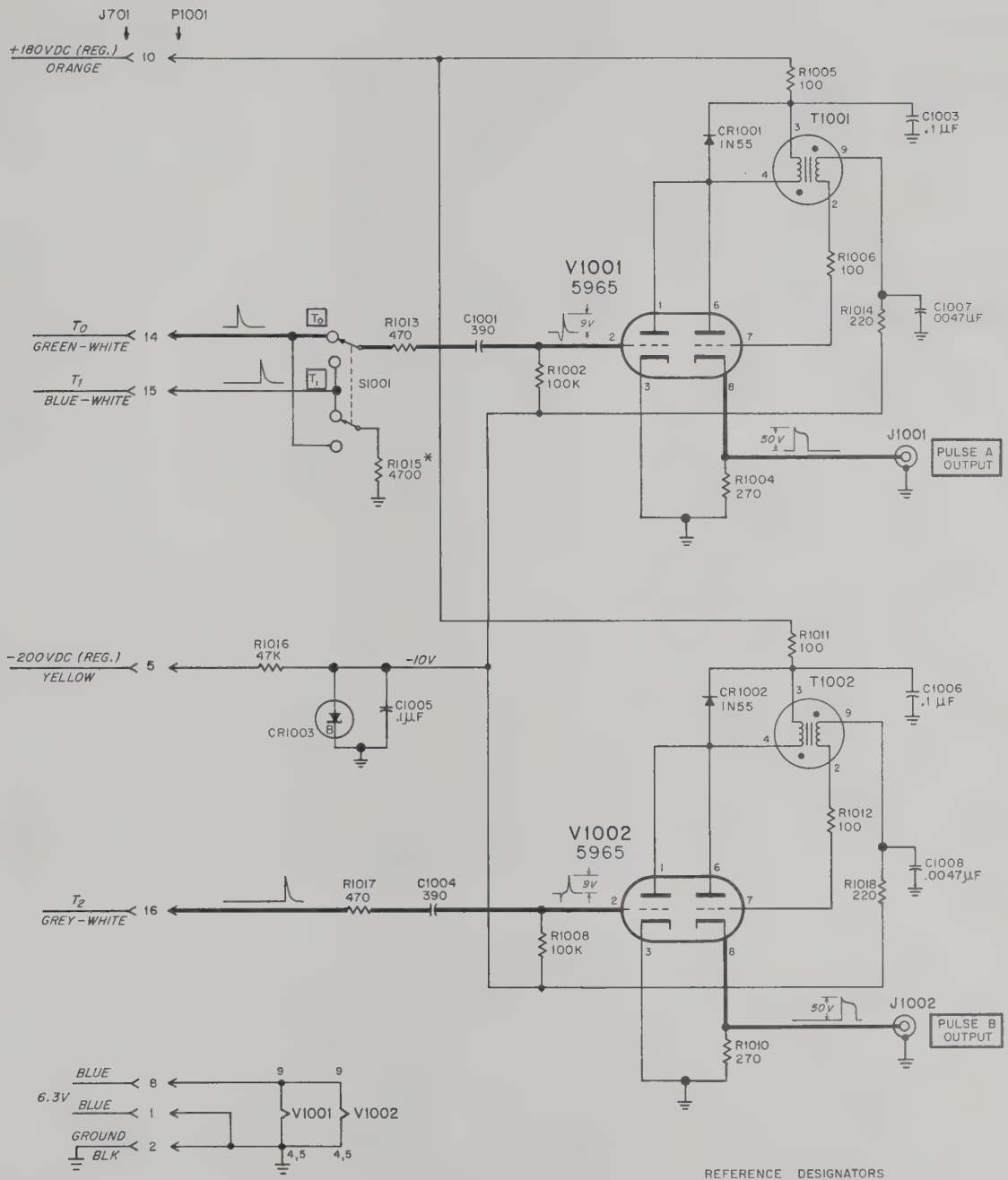



Figure 3-2. Bottom View of Model 219A






NOTE:

PLUG P1001 MATES WITH J701 OF 218A.

REFERENCE DESIGNATORS ON THIS DIAGRAM

| | | |
|---|---|---|
| C1001 | C1008 | DELETED |
| CR1001 | CR1003 | C1002 |
| J1001 | J1002 | R1001,1003, 1007, |
| R1001 | R1018 | R1009 |
| S1001 | | |
| T1001 | T1002 | |
| V1001 | V1002 | |

Figure 3-3. Model 219A Dual Trigger Unit

# SECTION IV
# REPLACEABLE PARTS

## 4-1 INTRODUCTION

This section contains information for ordering replacement parts for the 219A Dual Trigger Unit.

Table 4-1 lists replaceable parts in alpha-numerical order of their reference designators. Detailed information on a part used more than once in the instrument is listed opposite the first reference designator applying to the part. Other reference designators applying to the same part refer to the initial designator. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

1) Reference designator.

2) Full description of the part.

3) Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

4) Hewlett-Packard stock number.

5) Total quantity used in the instrument (TQ col).

6) Recommended spare quantity for complete maintenance during one year of isolated service (RS col).

## 4-2 ORDERING INFORMATION

To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
Rue du Vieux Billard No. 1
Geneva, Switzerland

Specify the following information for each part:

1) Model and complete serial number of instrument.

2) Hewlett-Packard stock number.

3) Circuit reference designator.

4) Description.

To order a part not listed in table 4-1, give a complete description of the part and include its function and location.

Table 4-1. Replaceable Parts

| Ckt Ref | Description | Mfr | ℌ Stock No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| C1 thru C1000 | Not assigned | | | | | | |
| C1001 | Capacitor: fixed, mica 390 pf ±5%, 500 vdcw | 00853 | 0140-0037 | 2 | 1 | | |
| C1002 | Not assigned | | | | | | |

Table 4-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| C1003 | Capacitor: fixed, mylar, 0.1 μf ±20%, 600 vdcw | 09134 | 0170-0022 | 3 | 1 | | |
| C1004 | Same as C1001 | | | | | | |
| C1005, C1006 | Same as C1003 | | | | | | |
| C1007, C1008 | Capacitor: fixed, ceramic, 4700 pf ±20%, 500 vdcw | 56289 | 0150-0086 | 2 | 1 | | |
| CR1 thru CR1000 | Not assigned | | | | | | |
| CR1001, CR1002 | Diode, germanium: 1N55A | 08792 | 1910-0003 | 2 | 2 | | |
| CR1003 | Diode, breakdown not assigned | 28480 | G-31G-10A | 1 | 1 | | |
| J1 thru J1000 | Not assigned | | | | | | |
| J1001, J1002 | Connector, BNC: 52 ohms, UG/1094/U | 91737 | 1250-0083 | 2 | 1 | | |
| P1 thru P1000 | Not assigned | | | | | | |
| P1001 | Connector, male: 16 pin | 02660 | 1251-0006 | 1 | 1 | | |
| R1 thru R1001 | Not assigned | | | | | | |
| R1002 | Resistor: fixed, composition, 100,000 ohms ±10%, 1/2 W | 01121 | 0687-1041 | 2 | 1 | | |
| R1003 | Not assigned | | | | | | |
| R1004 | Resistor: fixed, composition, 270 ohms ±10%, 1 W | 01121 | 0690-2711 | 2 | 1 | | |
| R1005, R1006 | Resistor: fixed, composition, 100 ohms ±10%, 1/2 W | 01121 | 0687-1011 | 4 | 1 | | |

* See introduction to this section

Table 4-1. Replaceable Parts (Cont'd)

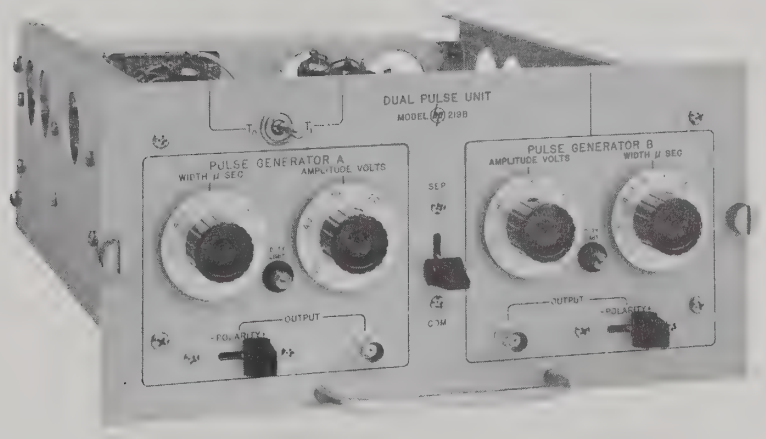
| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R1007 | Not assigned | | | | | | |
| R1008 | Same as R1002 | | | | | | |
| R1009 | Not assigned | | | | | | |
| R1010 | Same as R1004 | | | | | | |
| R1011, R1012 | Same as R1005 | | | | | | |
| R1013 | Resistor: fixed, composition, 470 ohms ± 10%, 1/2 W | 01121 | 0687-4711 | 2 | 1 | | |
| R1014 | Resistor: fixed, composition, 220 ohms ± 10%, 1/2 W | 01121 | 0687-2211 | 2 | 1 | | |
| R1015 | Resistor: fixed, composition, 4700 ohms ± 10%, 1/2 W Optimum value selected at factory; Average value shown. | 01121 | 0687-4721 | 1 | 1 | | |
| R1016 | Resistor: fixed, composition, 47,000 ohms ± 10%, 1/2 W | 01121 | 0693-4731 | 1 | 1 | | |
| R1017 | Same as R1013 | | | | | | |
| R1018 | Same as R1014 | | | | | | |
| S1 thru S1000 | Not assigned | | | | | | |
| S1001 | Switch, toggle: DPDT | 04009 | 3101-0005 | 1 | 1 | | |
| T1 thru T1000 | Not assigned | | | | | | |
| T1001, T1002 | Transformer, pulse | 28480 | 9130-0008 | 2 | 1 | | |
| V1 thru V1000 | Not assigned | | | | | | |
| V1001, V1002 | Tube, electron: 5965 | 80131 | 1932-0009 | 2 | 2 | | |
| | MISCELLANEOUS | | | | | | |
| | Screw, captive | 95264 | 0570-0032 | 2 | 0 | | |

* See introduction to this section

# OPERATING AND SERVICING MANUAL

## MODEL 219B
## DUAL PULSE GENERATOR

SERIALS PREFIXED: 120-




219B



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# SPECIFICATIONS (MODEL 219B)

When Plugged in Model 218A

| | |
|---|---|
| OUTPUT: | Two pulses, pulse A and pulse B |
| TIMING: | Pulse A, at $T_0$ or $T_1$ as selected by a switch. Pulse B, at $T_2$. |
| AMPLITUDE: | Individually adjustable, 0 to 50 volts peak, positive or negative polarity, available separately or from common jacks. |
| OUTPUT IMPEDANCE: | 50 ohms, for both separate or common connection. |
| WIDTH: | Individually adjustable 0.2 to 5 $\mu$sec. |
| RISE TIME: | 0.06 $\mu$sec |
| POWER: | Supplied by Ⓗ Model 218A |
| WEIGHT: | Net approximately 7 lbs |

Power Requirements for Independent Operation

| | |
|---|---|
| INPUT: | Amplitude: 20 volts minimum, positive pulse.<br>Rise time: 0.1 $\mu$sec minimum. |
| POWER: | +400 volts, unregulated (or regulated), 150 ma; +180 volts, regulated, 1 ma; -200 volts, regulated, 25 ma; 6.3 volts ac, 7.0 amp one side grounded; 6.3 volts ac, 4.4 amp floating at +180 volts when operating Model 219B. Connector mates with Amphenol "Blue Ribbon" connector #26-4200-16S. |

## CONTENTS

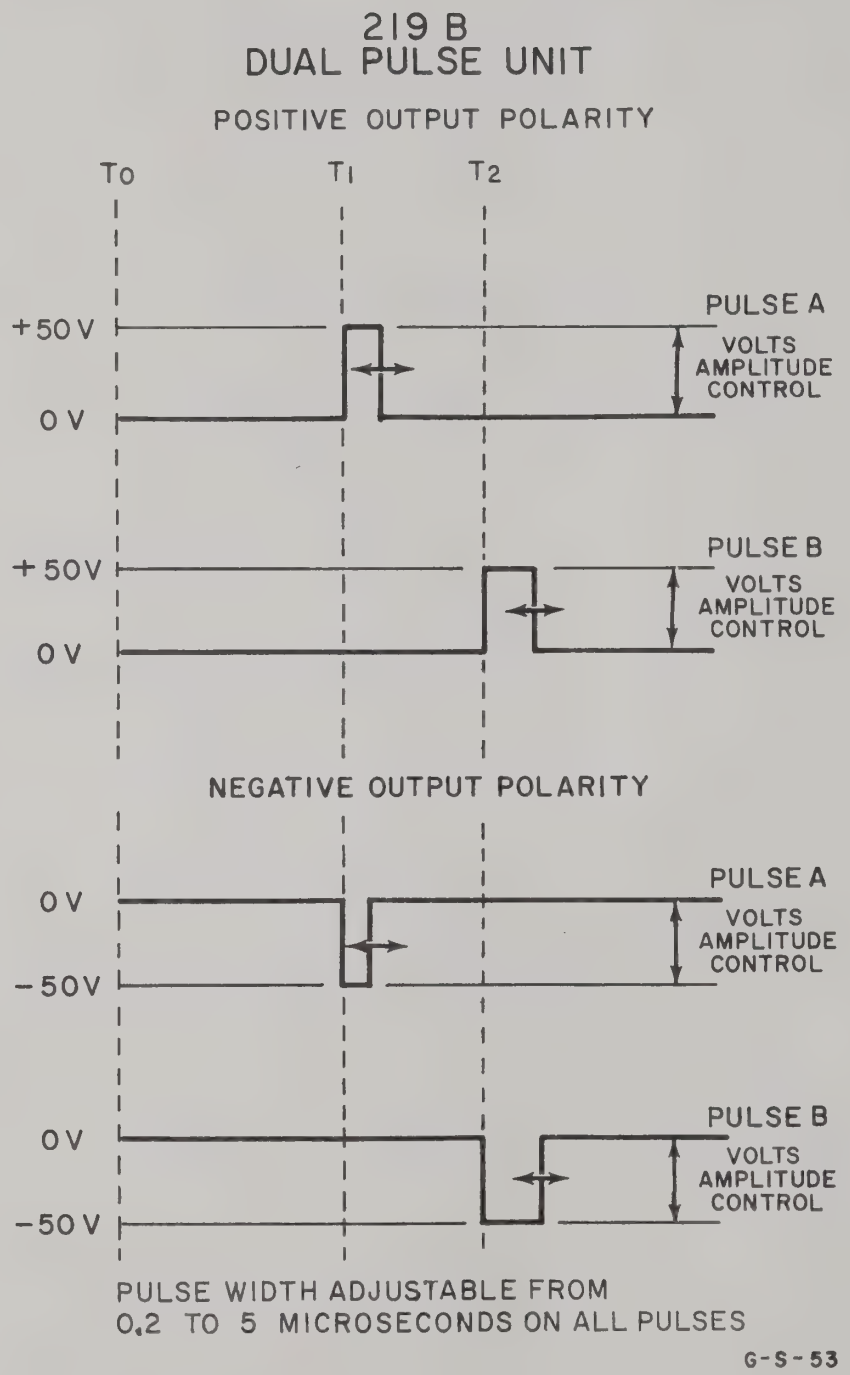



Figure 1-1. Dual Pulse Unit Output Characteristics Model 219B

# SECTION I
# GENERAL INFORMATION

## 1-1 INTRODUCTION

The Ⓗ Model 219B plug-in unit operates in conjunction with the Ⓗ Model 218A Digital Delay Generator. Two output pulses A and B are generated with the amplitude variable from 0 to 50 volts peak, positive or negative. The delay time settings of the 218A ($T_1$ and $T_2$) determine the timing of the pulses. The pulse width is variable from 0.2 to 5 μsec. Both pulses have a rise time of 0.06 μsec.

The leading edge of pulse A occurs at time $T_0$ or $T_1$ as selected by a switch. The leading edge of pulse B occurs at $T_2$. The output of the two pulse generators are available separately or from common jacks, maintaining 50 ohms source impedance in both output modes with either polarity.

## 1-2 CONNECTION TO MODEL 218A

All connections of the Ⓗ Model 219B Dual Pulse Generator to the Model 218A Digital Delay Generator are made through a plug-jack combination by inserting the 219B into the opening provided in the 218A. Operating voltages for the 219B are furnished by the Model 218A.

## 1-3 219B AS PULSE GENERATOR

The 219B Dual Pulse Generator can be operated as individual pulse generator, by supplying externally trigger pulses and providing the necessary supply voltage from standard laboratory power supplies. The current requirements for the various supply voltages and the mating plug for the connections are listed in Section V, Table of Replaceable Parts.

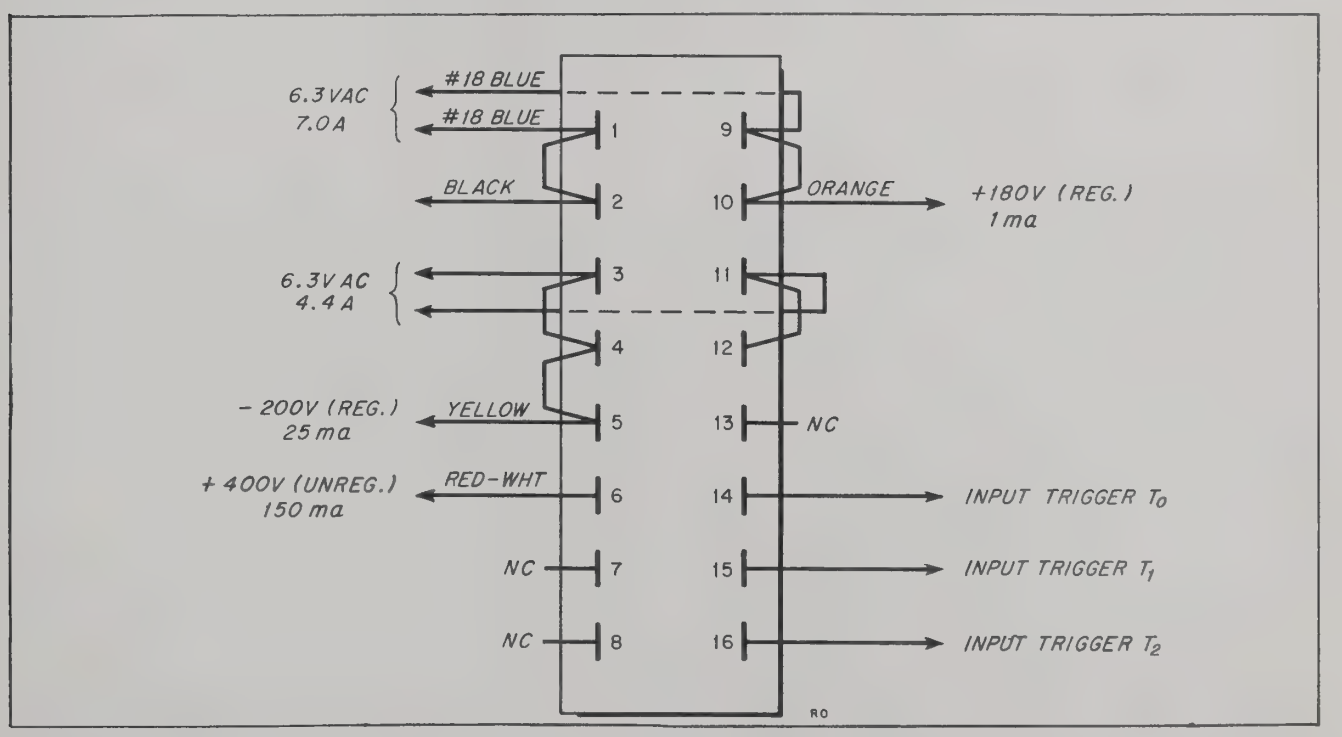
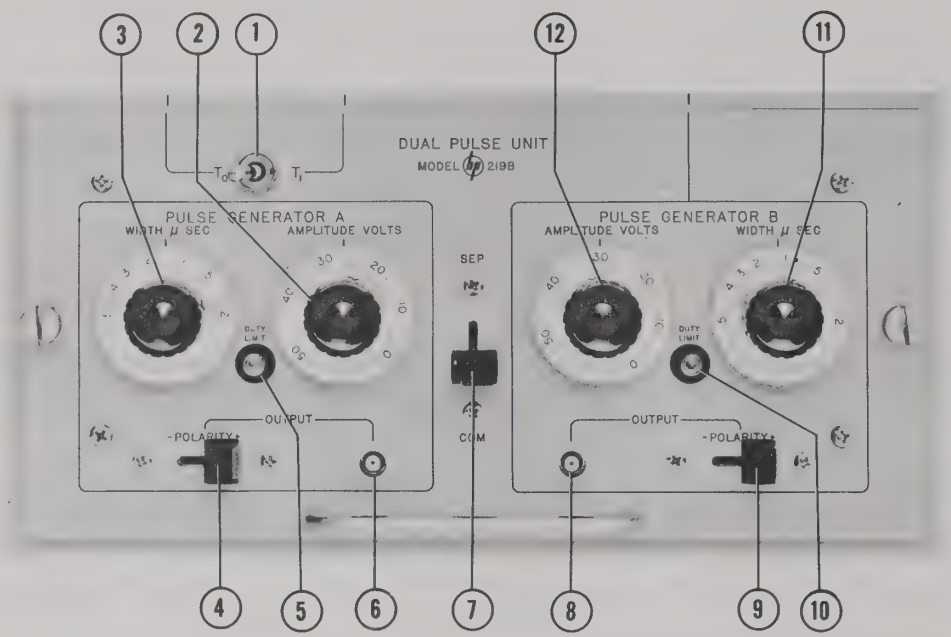



Figure 1-2. Connections to External Supply

## 219B OPERATING PROCEDURE




1. Select timing of leading edge of PULSE A, $T_0$ or $T_1$ (when operating as independent pulse generator, this switch selects between two input triggers).
2. Select AMPLITUDE of Output Pulse A.
3. Select WIDTH of Pulse A.
4. Select POLARITY of Pulse A.
5. DUTY LIMIT Indicator, see paragraph 2-2.
6. OUTPUT of Pulse A, 50 ohm source impedance.
7. Select Output Mode of Pulse A and Pulse B. In both output modes the output impedance remains 50 ohms. In COM. the two outputs (A and B) are directly added.
8. Output of Pulse B, 50 ohm source impedance
9. Select POLARITY of Pulse B.
10. DUTY LIMIT Indicator of Pulse B, see paragraph 2-2.
11. Select WIDTH of Pulse B.
12. Select AMPLITUDE of Pulse B.

Figure 2-1.

# SECTION II
# OPERATION

## 2-1 OPERATING PROCEDURES

The operating procedures given below supplement those in the 218A manual. Refer to operation of 218A with 219B plug-in unit.

The engraving on the front panel and the dials explain the function of the various controls and switches. The MICROSECOND DELAY dial setting of the 218A determines the timing of the leading pulse edge of $T_1$ and $T_2$ with respect to $T_0$.

The operation of the 219B is shown in Figure 2-1.

## 2-2 DUTY LIMIT

The combination of a long pulse and a high repetition frequency may cause the DUTY LIMIT relay to operate. Reducing either pulse width (219B) or pulse repetition frequency (218A internal or external), restores normal operation.

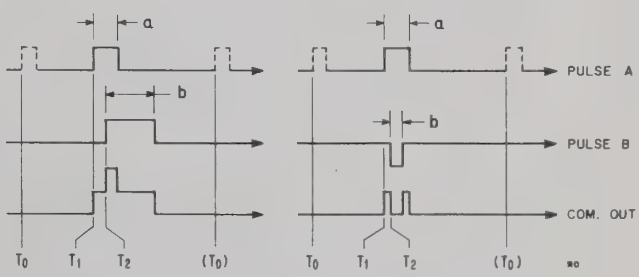
## 2-3 RESIDUAL OUTPUT

When the AMPLITUDE control is set to "0", a residual signal is observed at the output. This signal exists because the AMPLITUDE control follows the power amplifier. As a result the sharp transients of the pulse flanges are capacitively coupled to the output. To eliminate this effect, take a 47 ohm resistor (carbon, 1/2 watt) in series with a 2.2 ohm resistor (carbon, 1/2 watt) and connect the combination across the output (2.2 ohm resistor to ground). The signal across the 2.2 ohm resistor, although only approximately 2 volts maximum amplitude, will be virtually free of residual voltage transients.

## 2-4 APPLICATIONS

A number of applications for the 218A and its companion plug-in units are discussed in the Model 218A Operating and Servicing Manual.

The 219B makes it possible to synthesize complex pulses as indicated in Figure 2-2. With the selector switch in the COM position the two output pulses are linearly added regardless of the polarity chosen.




a = WIDTH OF PULSE A (0.2 - 5 μSEC)
b = WIDTH OF PULSE B (0.2 - 5 μSEC)

Figure 2-2. Pulse Synthesis

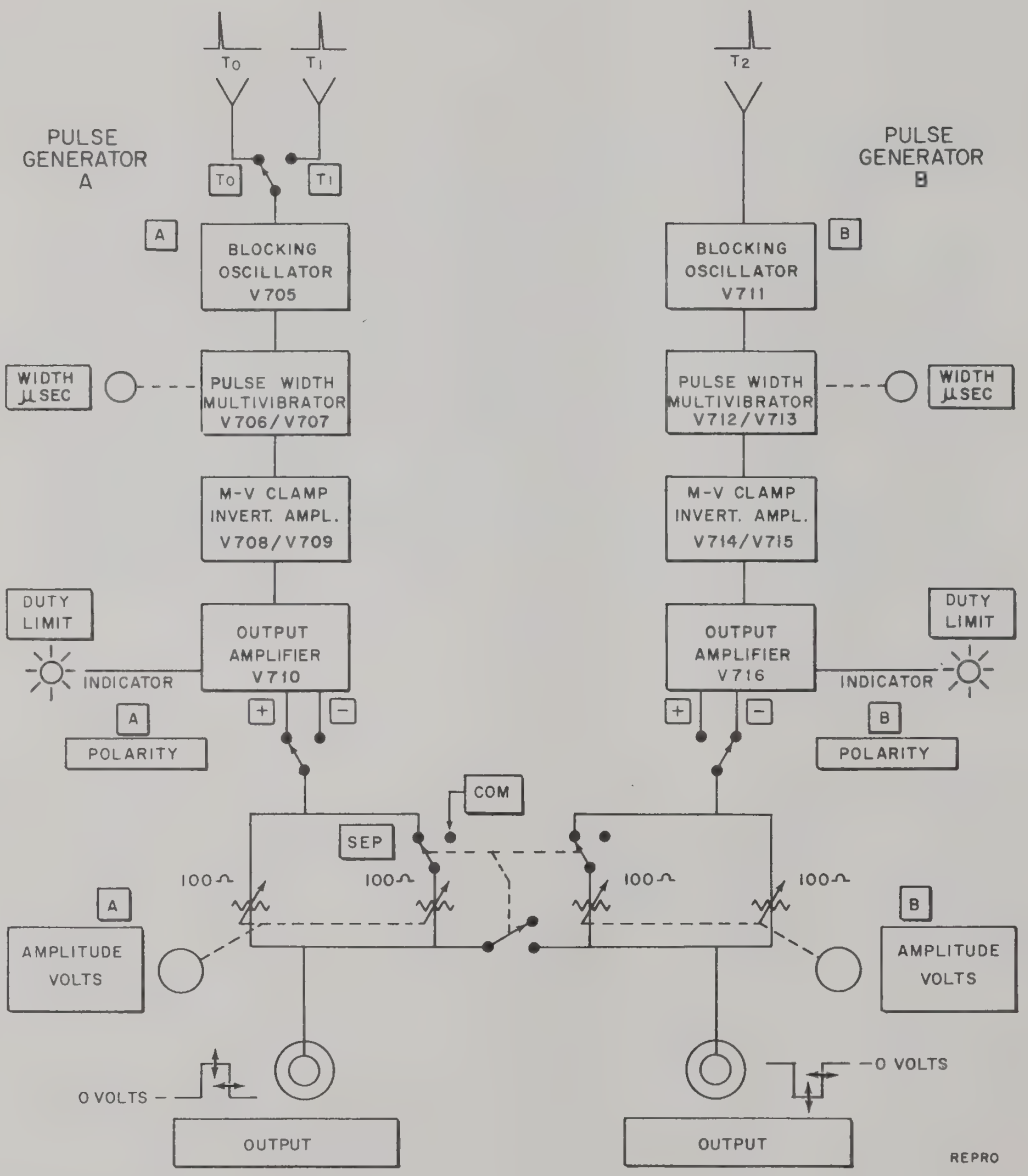



Figure 3-1. Block Diagram Model 219B

# SECTION III
# THEORY OF OPERATION

## 3-1 BLOCK DIAGRAM

The Ⓗ Model 219B consists of two identical pulse generator sections as shown in Figure 3-1. Output pulse A occurs at $T_0$ or $T_1$ as selected by a switch operated from the front panel. Output pulse B occurs always at $T_2$. The resistor network in the output contains the amplitude control, having two potentiometers operating in parallel to provide a constant output impedance for both output modes (SEP and COM).

## 3-2 CIRCUIT DESCRIPTION

Since there are two identical pulse section A and B, the following description will refer to the circuit of pulse generator A only. The complete circuit diagram is shown in Figure 4-6.

Depending on the position of switch S701, blocking oscillator V705 is triggered at $T_0$ or $T_1$. The negative output trigger pulse of blocking oscillator V705, triggers a conventional, monostable multivibrator consisting of V706 and V707. The operation of the monostable multivibrator is as follows:

Before a negative trigger pulse occurs, V707 is conducting and V706 is cut off. Then at $T_0$ or $T_1$ a sharp negative trigger pulse passing through diode CR702 and capacitor C709 cuts off tube V707. The sharp voltage rise of plate 6 of V707 is coupled to control grid of V706, driving V706 into conduction. The resulting plate drop of V706, allows control grid of V707 to remain negative, since both sides of C709 drop and thus not changing the initial charge condition of C709. This state is not stable, however, as capacitors C708 and C709 start charging positively through R727 and R728. Control grid of V707 raises until V707 becomes conducting again. Multivibrator clamp V708A operates as a cathode follower, limits the voltage rise of control grid of V707 by clamping it through diode CR703 to a fixed positive dc potential.

The width of the positive pulse appearing on plate of V707 is controlled by varying the time constant of the RC circuit with R728 (operated from the front panel) and C708 (width calibration). The output pulse of the multivibrator is amplified in V709, inverted in T702 and fed to cathode follower V708B. Output amplifier V710 is driven by a positive pulse from cathode follower V708B.

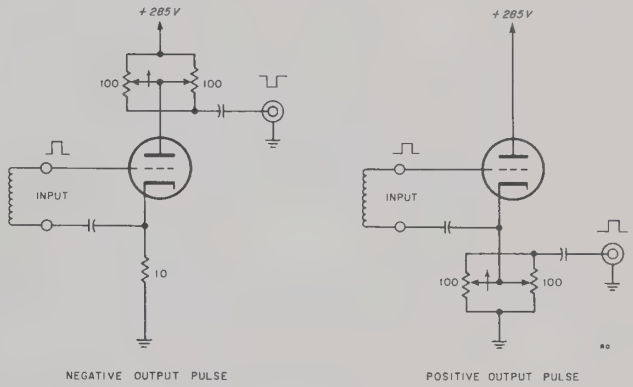



Figure 3-2. Output Pulse Polarity

Figure 3-2 illustrates the principle of operation of the output amplifier V710. For either polarity of the output pulse, the output amplifier V710 operates as a plate load amplifier, since the driving signal is applied between control grid and cathode for both output pulse polarities.

For a positive output pulse, the output load is in the cathode circuit. When a positive pulse drives the tube into conduction, the cathode potential raises, without degenerating the input signal. Thus the amplifier basically still operates as a plate loaded amplifier, delivering an output signal that is in phase with the input signal.

The network sections at the output of the two pulse generators A and B provide a constant 50 ohm source. impedance for separate or common pulse output.

### 3-3 DUTY LIMIT CIRCUIT

Relay RL701 is activated, if output stage V710 draws excessive plate current. Contact B of RL701 disconnects the screen supply voltage of inverting amplifier V709.

The output of V709 is reduced. With the driving signal of V710 decreased, plate current of V710 drops until relay RL710 is released. The relay starts to vibrate until the pulse width or the repetition frequency is lowered.

### 3-4 POWER SUPPLY REGULATOR

Three series regulator tubes and a control tube are located on the circuit board, to supply +285 volt regulated from the unregulated +400 volt supply in the 218A.

# SECTION IV
# MAINTENANCE

## 4-1 INTRODUCTION

This section contains information for the servicing and adjusting of the Model 219B Dual Pulse Generator unit.

## 4-2 TEST EQUIPMENT

The following test equipment is needed to service the Model 219B:

1) High Frequency Oscilloscope, such as ℌ Model 150A or equivalent, with Dual Trace plug-in unit Model 152B.

2) DC Vacuum Tube Voltmeter, with at least 100 megohms input impedance. ℌ Model 410A/B equivalent.

## 4-3 ADJUSTMENTS

The Model 219B requires two adjustments; a) Adjusting Pulse Width; b) Adjusting Pulse Amplitude.

The instrument setup, necessary for the two adjustments, is shown in Figure 4-1, Calibration Pulse Width.

A. ADJUSTMENT OF PULSE WIDTH

1) Set PULSE WIDTH control of Pulse A to 1 μsec.

2) Compare with pattern on oscilloscope, output B, and slip dial to 1 μsec if necessary.

3) Set PULSE WIDTH control to 5 μsec.

4) Adjust C708 for 5 μsec ± .2 μsec pulse width.

5) Repeat step 1 through 4 for optimum dial tracking.

6) Repeat step 1 through 5 for output Pulse B.

B. ADJUSTMENT OF PULSE AMPLITUDE

Use setup of Figure 4-1 with the following changes:

(5) Set AMPLITUDE of Pulse A and B to 50 volts.

(6) Connect output of Pulse A to vertical input A of oscilloscope, dc coupled.

(7) Connect output B to vertical input B, dc coupled.

Before making the adjustment, make sure that the two vertical inputs of the oscilloscope are calibrated.

1) Observe Output Pulse A.

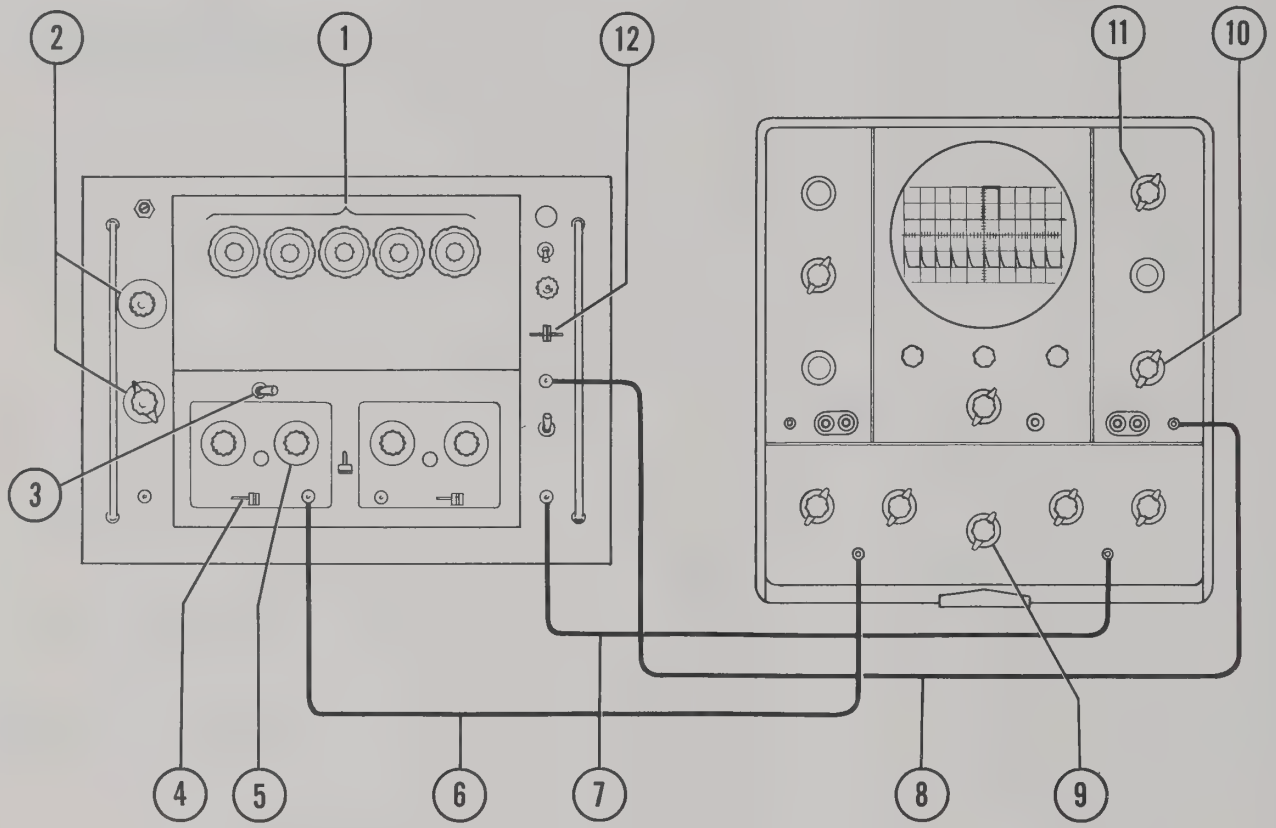
2) Adjust AMPLITUDE CALIBRATION control R746 for 50 volts amplitude. Using 10 volts/cm vertical sensitivity, the amplitude of the output pulse should be adjusted to 5 cm ± 0.2 cm (= ± 4%).

3) Repeat step 2 for Output Pulse B, adjusting Amplitude Calibration control R790.

## 4-4 TROUBLE SHOOTING

Trouble shooting of the 219B unit is most conveniently done with the oscilloscope using the signal tracing method. There are two identical pulse circuit sections. The signal tracing chart (Figure 4-2) applied to pulse section A and refers to components possibly causing the trouble symptom. However, the chart applies also to pulse circuit section B, when referred to the analogous of section A.

## CALIBRATION PULSE WIDTH




1. Set both MICROSECOND DELAY dials to 0005.0.
2. Set internal repetition frequency to 10 kc.
3. Set switch to $T_1$.
4. Set switch to polarity (+).
5. Set AMPLITUDE to 20 volts.
6. Connect output to vertical input of channel A.
7. Connect INT 1 MC output to vertical input channel B.
8. Connect SYNC OUT to EXT. SYNC input of oscilloscope.
9. Set VERTICAL PRESENTATION to ALTERNATE.
10. SYNC oscilloscope on EXT. AC. Set TRIGGER SLOPE to (+).
11. Set sweep time to 1.0 μsec/cm.
12. Set SYNC OUT selector to $T_0$.

Figure 4-1

For trouble shooting use setup of Figure 4-1 with the following alterations:

(6) Disconnect OUTPUT A of 219B from VERTICAL INPUT of oscilloscope.

Connect oscilloscope probe to VERTICAL INPUT A and check the points indicated on Figure 4-2.

(7) Disconnect COUNT. FREQ. OUTPUT of 218A from VERTICAL INPUT B of oscilloscope.

(9) Set VERTICAL PRESENTATION to INPUT A.

(11) Set SWEEP TIME to 1 μsec/cm.

(12) Set SYNC OUT selector switch to $T_0$.

Diode Replacement

There are three diode types used in the instrument. Use exact replacement diode. Observe polarity when installing new diode. The color code bands mark the cathode.

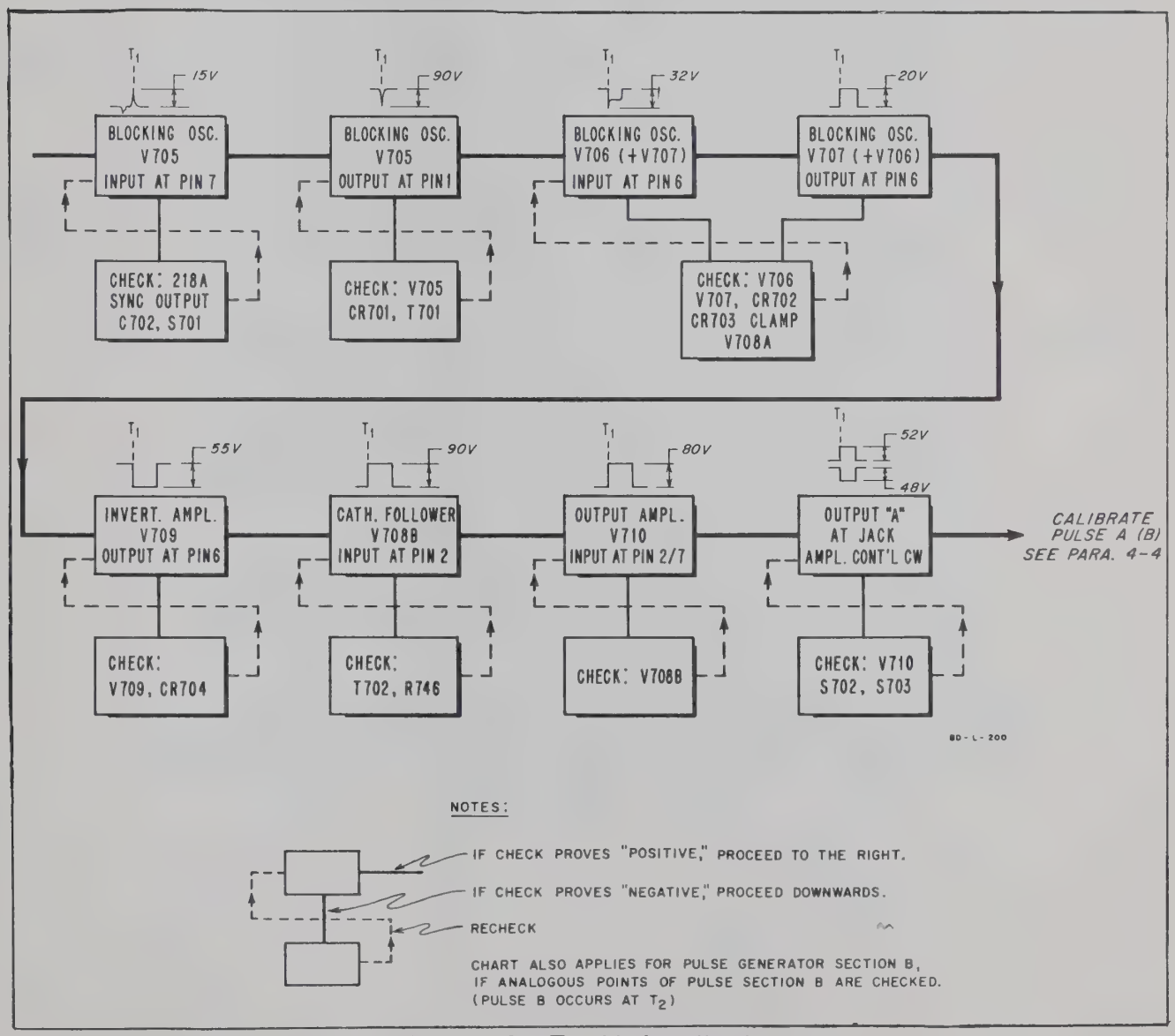




Figure 4-2. Trouble Localization

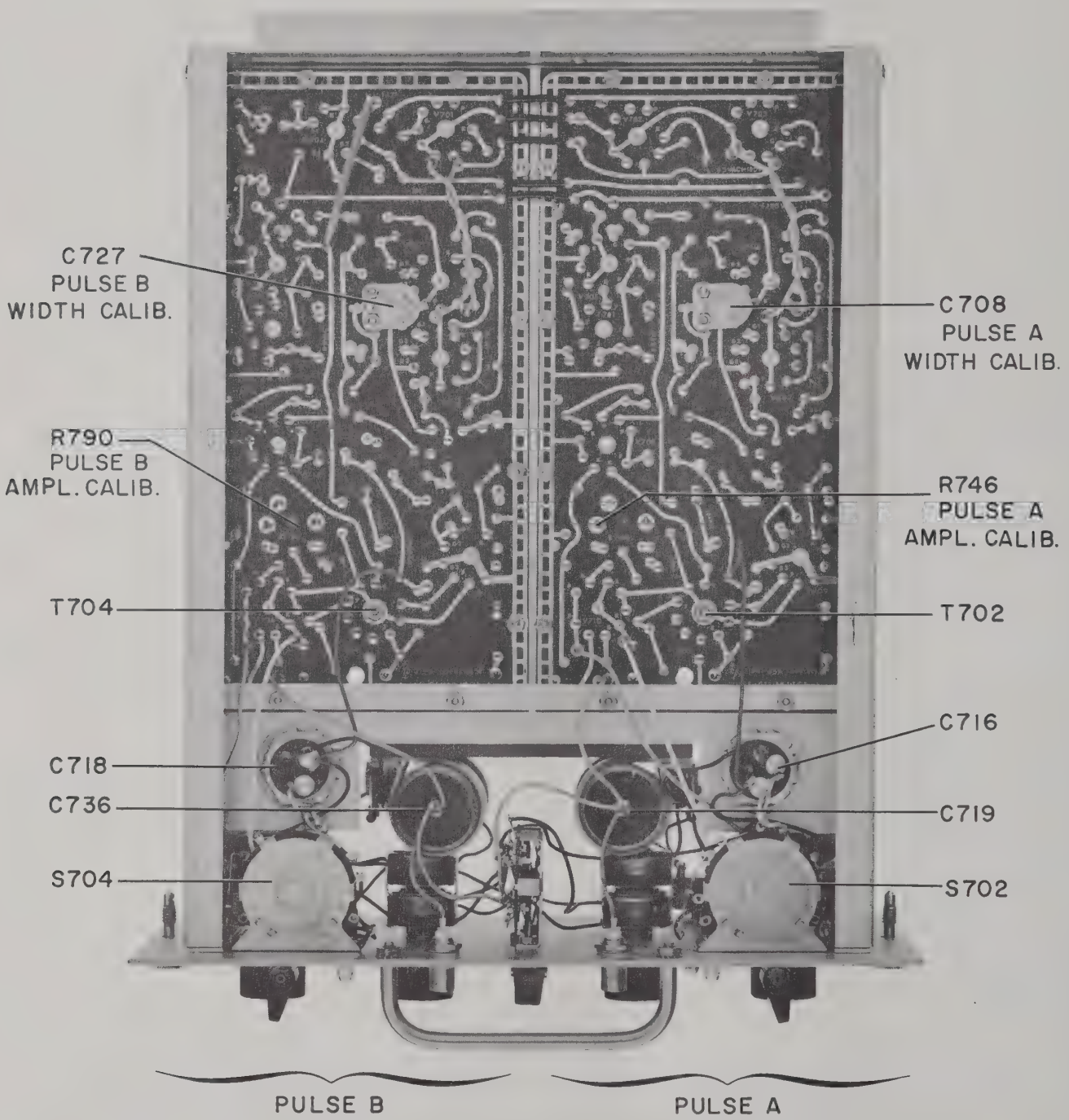



Figure 4-3. Top View of Model 219B

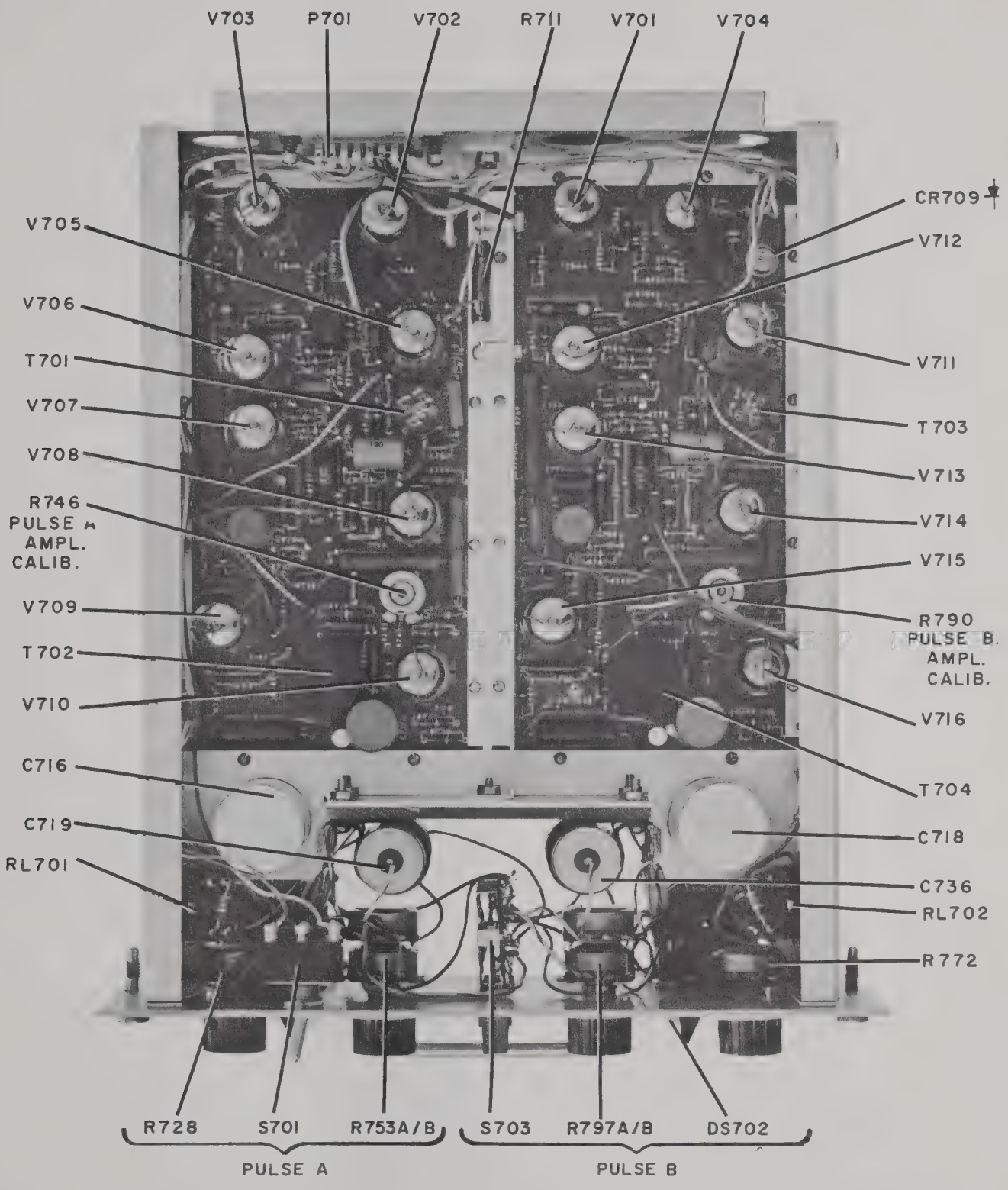



Figure 4-4. Bottom View of Model 219B

## SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

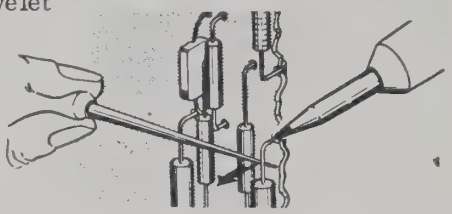
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

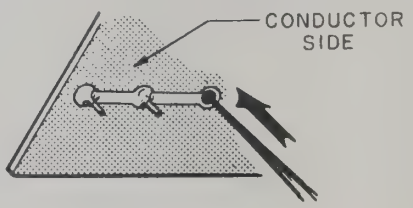
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

WARNING: If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

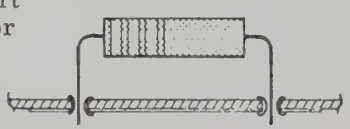
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.



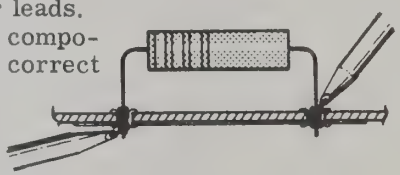
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.




3. Bend clean tinned lead on new part and carefully insert through eyelets or holes in board.

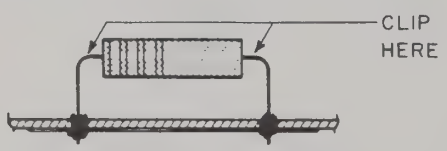


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

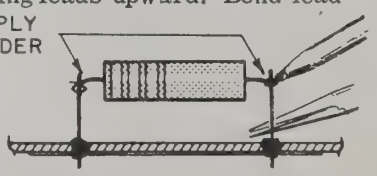


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.




2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.




This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

# MANUAL CHANGES

MODEL 219A

DUAL TRIGGER UNIT

Manual Serial Prefixed: 119-
Manual Printed: 7/61

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

| Instrument Serial Prefix | Make Manual Changes | Instrument Serial Prefix | Make Manual Changes |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

ERRATA: R1016: Change description to read: resistor, fixed, composition, 47,000 ohms ± 10%, 2W.

3/12/62

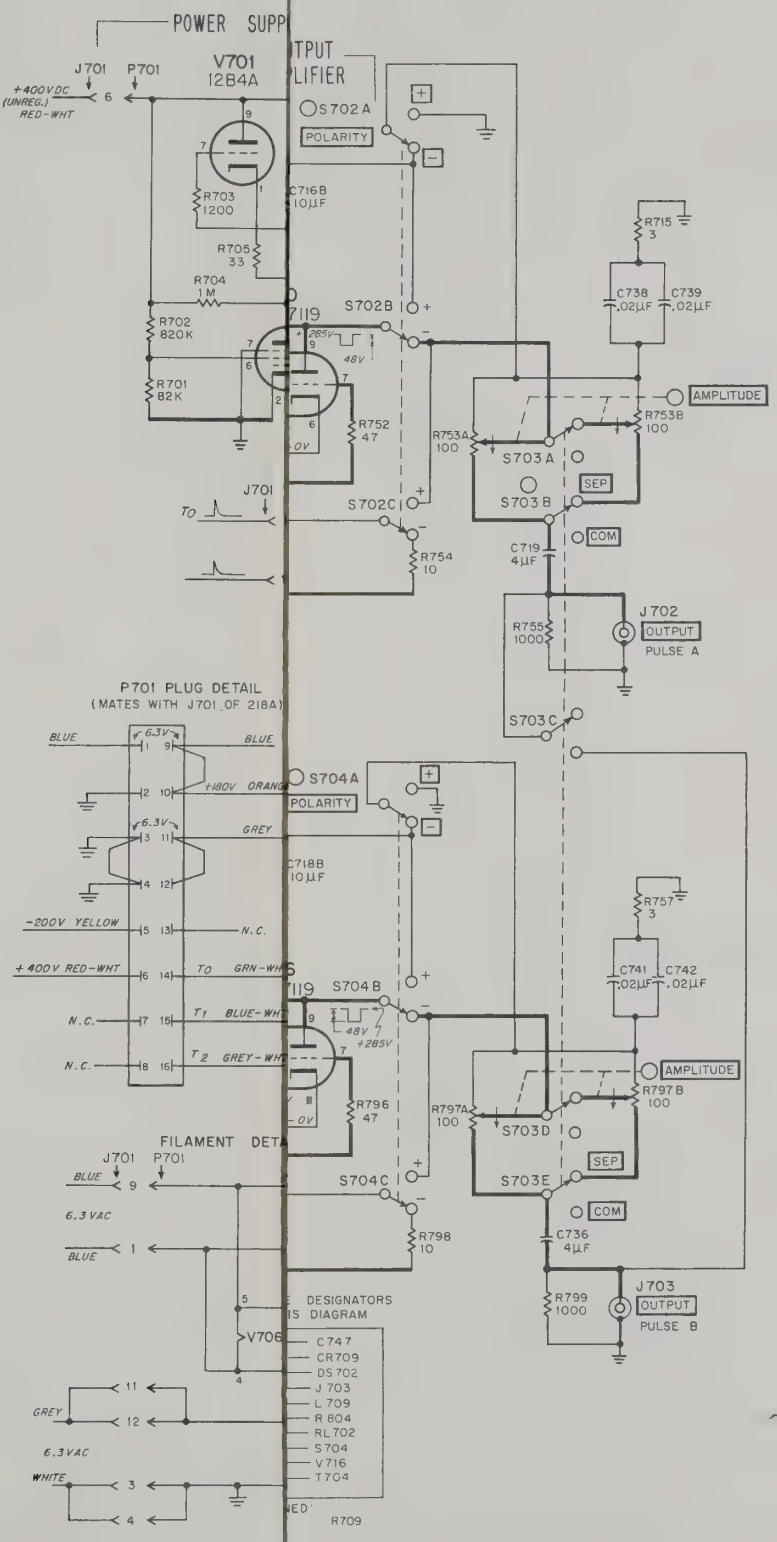



Figure 4-5. Model 219B Dual Pulse Unit

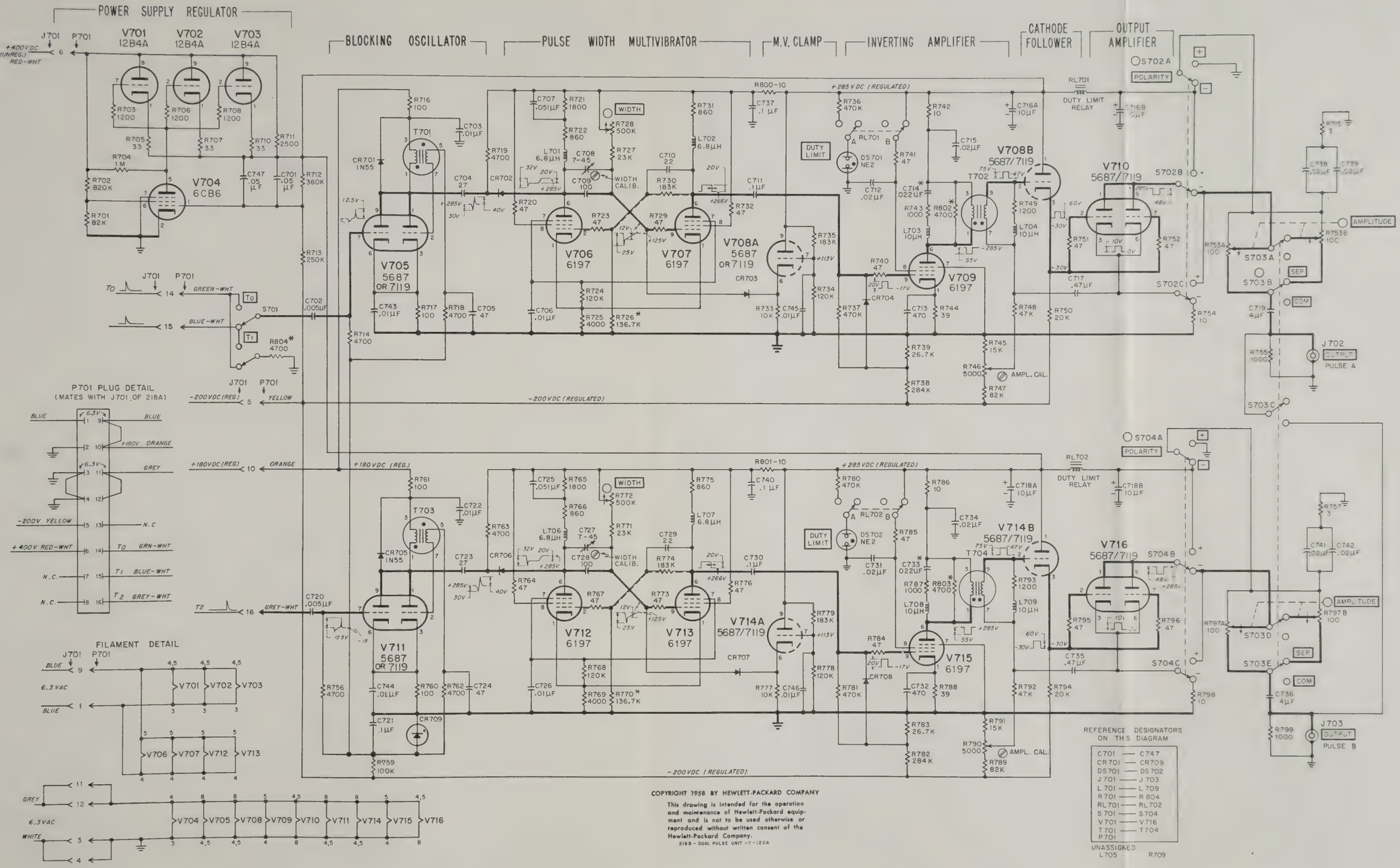







Figure 4-5. Model 219B Dual Pulse Unit

# SECTION V
# REPLACEABLE PARTS

## 5-1 INTRODUCTION

This section contains information for ordering replacement parts for the 219B Dual Pulse Generator.

Table 5-1 lists replaceable parts in alpha-numerical order of their reference designators. Detailed information on a part used more than once in the instrument is listed opposite the first reference designator applying to the part. Other reference designators applying to the same part refer to the initial designator. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

1) Reference designator.

2) Full description of the part.

3) Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

4) Hewlett-Packard stock number.

5) Total quantity used in the instrument (TQ col).

6) Recommended spare quantity for complete maintenance during one year of isolated service (RS col).

## 5-2 ORDERING IINFORMATION

To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
Rue du Vieux Billard No. 1
Geneva, Switzerland

Specify the following information for each part:

1) Model and complete serial number of instrument.

2) Hewlett-Packard stock number.

3) Circuit reference designator.

4) Description.

To order a part not listed in table 5-1, give a complete description of the part and include its function and location.

Table 5-1. Replaceable Parts

| Ckt Ref | Description | Mfr | ℗ Stock No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| C1 thru C700 | Not assigned | | | | | | |
| C701 | Capacitor: fixed, ceramic, 0.05 μf ±20%, 400 vdcw | 0000R | 0150-0052 | 2 | 1 | | |
| C702 | Capacitor: fixed, ceramic, 0 0.005 μf, 500 vdcw | 96095 | 0150-0014 | 2 | 1 | | |
| C703 | Capacitor: fixed ceramic, 0.1 μf ±20%, 1000 vdcw | 56289 | 0150-0012 | 8 | 2 | | |
| C704 | Capacitor: fixed, mica, 27 pf ± 10%, 500 vdcw | 00853 | 0140-0005 | 2 | 1 | | |

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| C705 | Capacitor: fixed, mica, 47 pf ± 10%, 500 vdcw | 76433 | 0140-0032 | 2 | 1 | | |
| C706 | Same as C703 | | | | | | |
| C707 | Capacitor: fixed, paper, 0.051 μf ± 10%, 400 vdcw | 14655 | 0160-0043 | 2 | 1 | | |
| C708 | Capacitor: variable, ceramic, 7-45 pf, 500 vdcw | 72982 | 0130-0001 | 2 | 1 | | |
| C709 | Capacitor: fixed, mica, 100 pf ± 5%, 500 vdcw | 76433 | 0140-0041 | 2 | 1 | | |
| C710 | Capacitor: fixed, mica, 22 pf ± 5%, 500 vdcw | 00853 | 0140-0034 | 2 | 1 | | |
| C711 | Capacitor: fixed, paper, 0.1 μf ± 10%, 400 vdcw | 00656 | 0160-0050 | 2 | 1 | | |
| C712 | Capacitor: fixed, ceramic, 0.02 μf, -0%+ 100%, 600 vdcw | 91418 | 0150-0024 | 8 | 2 | | |
| C713 | Capacitor: fixed, mica, 470 pf ± 10%, 500 vdcw | 00853 | 0140-0027 | 2 | 1 | | |
| C714 | Capacitor: fixed, paper, 0.022 μf, ± 10%, 600 vdcw Optimum value selected at factory. Average value shown. | 56289 | 0160-0003 | 2 | 1 | | |
| C715 | Same as C712 | | | | | | |
| C716A, 716B | Capacitor: fixed, electrolytic, 10 x 10 μf, 450 vdcw | 56289 | 0180-0052 | 2 | 1 | | |
| C717 | Capacitor: fixed, paper, 0.47 μf ± 10%, 400 vdcw | 00656 | 0160-0051 | 2 | 1 | | |
| C718A, B | Same as C716 | | | | | | |
| C719 | Capacitor: fixed, mylar, 4 μf ± 10%, 400 vdcw | 56289 | 0170-0036 | 2 | 1 | | |
| C720 | Same as C702 | | | | | | |
| C721 | Capacitor: fixed, ceramic, 0.1 μf + 80%-20%, 50 vdcw | 56289 | 0150-0121 | 1 | 1 | | |
| C722 | Same as C703 | | | | | | |
| C723 | Same as C704 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| C724 | Same as C705 | | | | | | |
| C725 | Same as C707 | | | | | | |
| C726 | Same as C703 | | | | | | |
| C727 | Same as C708 | | | | | | |
| C728 | Same as C709 | | | | | | |
| C729 | Same as C710 | | | | | | |
| C730 | Same as C711 | | | | | | |
| C731 | Same as C712 | | | | | | |
| C732 | Same as C713 | | | | | | |
| C733 | Same as C714 | | | | | | |
| C734 | Same as C712 | | | | | | |
| C735 | Same as C717 | | | | | | |
| C736 | Same as C719 | | | | | | |
| C737 | Capacitor: fixed, mylar, 0.1 μf ±20%, 600 vdcw | 09134 | 0170-0022 | 2 | 1 | | |
| C738, 739 | Same as C712 | | | | | | |
| C740 | Same as C737 | | | | | | |
| C741, 742 | Same as C712 | | | | | | |
| C743 thru C746 | Same as C703 | | | | | | |
| C747 | Same as C701 | | | | | | |
| CR1 thru CR700 | Not assigned | | | | | | |
| CR701 | Diode, germanium: 1N55 | 08792 | 1910-0003 | 2 | 2 | | |
| CR702 | Diode, germanium: 5 ma, 75 PIV #HD2135 | 73293 | 1910-0011 | 4 | 4 | | |
| CR703 | Diode, germanium: #S142G | 03877 | 1910-0001 | 2 | 2 | | |
| CR704 | Same as CR702 | | | | | | |
| CR705 | Same as CR701 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| CR706 | Same as CR702 | | | | | | |
| CR707 | Same as CR703 | | | | | | |
| CR708 | Same as CR702 | | | | | | |
| CR709 | Diode, breakdown | 28480 | G-31G-15L | 1 | 1 | | |
| DS1 thru DS700 | Not assigned | | | | | | |
| DS701, 702 | Lampholder Assembly: neon type 1369 | 03797 | 1450-0025 | 2 | 2 | | |
| J1 thru J701 | Not assigned | | | | | | |
| J702, 703 | Connector, female: BNC, UG/1094/U | 91737 | 1250-0083 | 2 | 1 | | |
| L1 thru L700 | Not assigned | | | | | | |
| L701, 702 | Inductor: 6.8 μf, ±10%, 0.7 ohms | 99848 | 9140-0026 | 4 | 1 | | |
| L703, 704 | Inductor: 10 μh, ±10% | 99848 | 9140-0032 | 4 | 1 | | |
| L705 | Not assigned | | | | | | |
| L706, 707 | Same as L701 | | | | | | |
| L708, 709 | Same as L703 | | | | | | |
| P1 thru P700 | Not assigned | | | | | | |
| P701 | Connector, male: 16 pin | 02660 | 1251-0006 | 1 | 1 | | |
| R1 thru R700 | Not assigned | | | | | | |
| R701 | Resistor: fixed, composition, 82,000 ohms ±10%, 1/2 W | 01121 | 0687-8231 | 1 | 1 | | |
| R702 | Resistor: fixed, composition, 820,000 ohms ±10%, 1/2 W | 01121 | 0687-8241 | 1 | 1 | | |
| R703 | Resistor: fixed, composition, 1200 ohms ±10%, 1/2 W | 01121 | 0687-1221 | 3 | 1 | | |
| R704 | Resistor: fixed, composition, 1 megohm ±10%, 1/2 W | 01121 | 0687-1051 | 1 | 1 | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R705 | Resistor: fixed, composition, 33 ohms ±10%, 1/2 W | 01121 | 0687-3301 | 3 | 1 | | |
| R706 | Same as R703 | | | | | | |
| R707 | Same as R705 | | | | | | |
| R708 | Same as R703 | | | | | | |
| R709 | Not assigned | | | | | | |
| R710 | Same as R705 | | | | | | |
| R711 | Resistor: fixed, wirewound 2500 ohms ±5%, 20 W | 94310 | 0818-0019 | 1 | 1 | | |
| R712 | Resistor: fixed, deposited carbon, 360,000 ohms, ±1%, 1/2 W | 19701 | 0727-0235 | 1 | 1 | | |
| R713 | Resistor: fixed, deposited carbon, 250,000 ohms ±1%, 1/2 W | 19701 | 0727-0226 | 1 | 1 | | |
| R714 | Resistor: fixed, composition, 4700 ohms ±10%, 1/2 W | 01121 | 0687-4721 | 9 | 2 | | |
| R715 | Resistor: fixed, deposited carbon, 3 ohms ±1%, 1/2 W | 19701 | 0727-0002 | 2 | 1 | | |
| R716, R717 | Resistor: fixed, composition, 100 ohms ±10%, 1/2 W | 01121 | 0687-1011 | 4 | 1 | | |
| R718, 719 | Same as R714 | | | | | | |
| R720 | Resistor: fixed, composition, 47 ohms ±10%, 1/2 W | 01121 | 0687-4701 | 16 | 4 | | |
| R721 | Resistor: fixed, composition, 1800 ohms ±10%, 1/2 W | 01121 | 0687-1821 | 2 | 1 | | |
| R722 | Resistor: fixed, deposited carbon, 860 ohms ±1%, 1/2 W | 19701 | 0727-0092 | 4 | 1 | | |
| R723 | Same as R720 | | | | | | |
| R724 | Resistor: fixed, composition, 120,000 ohms, ±10%, 1/2 W | 01121 | 0687-1241 | 2 | 1 | | |
| R725 | Resistor: fixed, metal film, 4000 ohms ±10%, 5 W | 07115 | 0774-0001 | 2 | 1 | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R726 | Resistor: fixed, deposited carbon, 136,700 ohms ±1%, 1/2 W Optimum value selected at factory; Average value shown. | 19701 | 0727-0216 | 2 | 1 | | |
| R727 | Resistor: fixed, metal film, 23,000 ohms ±2%, 2 W | 07115 | 0763-0004 | 2 | 1 | | |
| R728 | Resistor: variable, composition, 500,000 ohms ±10%, 2 W | 01121 | 2100-0178 | 2 | 1 | | |
| R729 | Same as R720 | | | | | | |
| R730 | Resistor: fixed, deposited carbon, 183,000 ohms, ±1%, 1/2 W | 19701 | 0727-0220 | 4 | 1 | | |
| R731 | Same as R722 | | | | | | |
| R732 | Same as R720 | | | | | | |
| R733 | Resistor: fixed, metal film, 10,000 ohms ±5%, 4 W | 07115 | 0770-0004 | 2 | 1 | | |
| R734 | Resistor: fixed, deposited carbon, 120,000 ohms ±1%, 1/2 W | 19701 | 0727-0214 | 2 | 1 | | |
| R735 | Same as R730 | | | | | | |
| R736, R737 | Resistor: fixed, composition, 470,000 ohms ±10%, 1/2 W | 01121 | 0687-4741 | 4 | 1 | | |
| R738 | Resistor: fixed, deposited carbon, 284,000 ohms ±1%, 1/2 W | 19701 | 0727-0230 | 2 | 1 | | |
| R739 | Resistor: fixed, deposited carbon, 26,700 ohms ±1%, 1/2 W | 19701 | 0727-0183 | 2 | 1 | | |
| R740, 741 | Same as R720 | | | | | | |
| R742 | Resistor: fixed, composition, 10 ohms ±10%, 1/2 W | 01121 | 0687-1001 | 4 | 1 | | |
| R743 | Resistor: fixed, composition, 1000 ohms ±10%, 1/2 W | 01121 | 0687-1021 | 4 | 1 | | |
| R744 | Resistor: fixed, composition, 39 ohms ±10%, 1/2 W | 01121 | 0687-3901 | 2 | 1 | | |
| R745 | Resistor: fixed, composition, 15,000 ohms ±10%, 1/2 W | 01121 | 0687-1531 | 2 | 1 | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R746 | Resistor: variable, composition, 5000 ohms ±30%, 1/3 W | 11237 | 2100-0091 | 2 | 1 | | |
| R747 | Resistor: fixed, composition, 82,000 ohms ±10%, 1 W | 01121 | 0690-8231 | 2 | 1 | | |
| R748 | Resistor: fixed, composition, 47,000 ohms ±10%, 1/2 W | 01121 | 0687-4731 | 2 | 1 | | |
| R749 | Resistor: fixed, deposited carbon, 1200 ohms ±1%, 1/2 W | 19701 | 0727-0105 | 2 | 1 | | |
| R750 | Resistor: fixed, metal film, 20,000 ohms ±10%, 4 W | 07115 | 0771-0004 | 2 | 1 | | |
| R751, 752 | Same as R720 | | | | | | |
| R753A, R753B | Resistor: variable composition, two sect. 100 ohms ±10%, per sect. 2 W | 01121 | 2100-0179 | 2 | 1 | | |
| R754 | Same as R742 | | | | | | |
| R755 | Same as R743 | | | | | | |
| R756 | Same as R714 | | | | | | |
| R757 | Same as R715 | | | | | | |
| R758 | Not assigned | | | | | | |
| R759 | Resistor: fixed, composition, 100,000 ohms ±10%, 1 W | 01121 | 0390-1041 | 1 | 1 | | |
| R760, 761 | Same as R716 | | | | | | |
| R762, 763 | Same as R714 | | | | | | |
| R764 | Same as R720 | | | | | | |
| R765 | Same as R721 | | | | | | |
| R766 | Same as R722 | | | | | | |
| R767 | Same as R720 | | | | | | |
| R768 | Same as R724 | | | | | | |
| R769 | Same as R725 | | | | | | |
| R770 | Same as R726 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R771 | Same as R727 | | | | | | |
| R772 | Same as R728 | | | | | | |
| R773 | Same as R720 | | | | | | |
| R774 | Same as R730 | | | | | | |
| R775 | Same as R722 | | | | | | |
| R776 | Same as R720 | | | | | | |
| R777 | Same as R733 | | | | | | |
| R778 | Same as R734 | | | | | | |
| R779 | Same as R730 | | | | | | |
| R780, 781 | Same as R736 | | | | | | |
| R782 | Same as R738 | | | | | | |
| R783 | Same as R739 | | | | | | |
| R784, 785 | Same as R720 | | | | | | |
| R786 | Same as R742 | | | | | | |
| R787 | Same as R743 | | | | | | |
| R788 | Same as R744 | | | | | | |
| R789 | Same as R747 | | | | | | |
| R790 | Same as R746 | | | | | | |
| R791 | Same as R745 | | | | | | |
| R792 | Same as R748 | | | | | | |
| R793 | Same as R749 | | | | | | |
| R794 | Same as R750 | | | | | | |
| R795, 796 | Same as R720 | | | | | | |
| R797A, B | Same as R753 | | | | | | |
| R798 | Same as R742 | | | | | | |
| R799 | Same as R743 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R800, 801 | Resistor: fixed, composition, 10 ohms ± 10%, 2 W | 01121 | 0690-1001 | 2 | 1 | | |
| R802 thru R804 | Same as R714 Optimum value selected at factory; Average value shown. | | | | | | |
| RL 1 thru RL700 | Not assigned | | | | | | |
| RL701, RL702 | Relay, DPDT: 30 ma ± 10% | 77342 | 0490-0021 | 2 | 1 | | |
| S1 thru S700 | Not assigned | | | | | | |
| S701 | Switch, toggle: DPDT | 04009 | 3101-0005 | 1 | 1 | | |
| S702 thru S704 | Switch, lever: 5 pole, 2 pos. | 37942 | 3100-0176 | 3 | 1 | | |
| T1 thru T700 | Not assigned | | | | | | |
| T701 | Transformer, pulse | 28480 | 219B-60B | 2 | 1 | | |
| T702 | Transformer, pulse | 28480 | 219B-60A | 2 | 1 | | |
| T703 | Same as T701 | | | | | | |
| T704 | Same as T702 | | | | | | |
| V1 thru V700 | Not assigned | | | | | | |
| V701 thru V703 | Tube, electron: 12B4A | 80131 | 1921-0010 | 3 | 3 | | |
| V704 | Tube, electron: 6CB6 | 80131 | 1923-0028 | 1 | 1 | | |
| V705 | Tube, electron: 7119 | 80131 | 1932-0016 | 6 | 6 | | |
| V706, 707 | Tube, electron: 6197 | 80131 | 1923-0005 | 6 | 6 | | |
| V708 | Same as V705 | | | | | | |
| V709 | Same as V706 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts ( Cont'd)

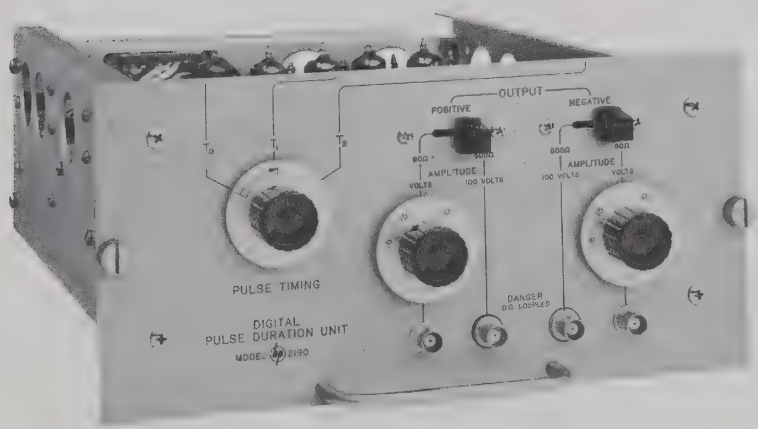
| Ckt Ref | Description | Mfr * | Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| V710, V711 | Same as V705 | | | | | | |
| V712, V713 | Same as V706 | | | | | | |
| V714 | Same as V705 | | | | | | |
| V715 | Same as V706 | | | | | | |
| V716 | Same as V705 | | | | | | |
| | MISCELLANEOUS | | | | | | |
| | Knob: lever switch<br>POLARITY<br>SEP. - COM. | 28480 | G-74AA | 3 | 0 | | |
| | Knob:<br>AMPLITUDE<br>WIDTH | 28480 | G-74H | 4 | 0 | | |
| | Screw, captive | 95264 | 0570-0032 | 2 | 0 | | |

* See introduction to this section

# OPERATING AND SERVICING MANUAL

## MODEL 219C
## PULSE DURATION GENERATOR

SERIALS PREFIXED: 123-




219C



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# SPECIFICATIONS (MODEL 219C)

When Plugged in Model 218A

| | |
|---|---|
| OUTPUT: | Starts at $T_0$, ends at $T_1$, or digitally delayed from $T_0$ to $T_1$ with start at $T_1$, end at $T_2$ as selected by a switch. |
| POLARITY: | Positive and negative pulses available simultaneously. |
| AMPLITUDE: | Adjustable, 0 to at least 15 volts peak into an open circuit from 90 ohms source impedance or at least 90 volts peak into an open circuit from 500 ohm source impedance. |
| RICE AND DECAY TIME: | 0.03 $\mu$sec for 90 ohm output |
| POWER: | Supplied by 218A |
| WEIGHT: | Net 5 lbs |

Power Requirements for Independent Operation

| | |
|---|---|
| INPUT: | Amplitude: 20 volts minimum, positive pulse.<br>Rise time: 0.1 $\mu$sec minimum. |
| POWER: | +180 volts, regulated, 2.5 ma. -200 volts, regulated, 350 ma. 6.3 volts, ac, 7.8 amperes, one side grounded. 6.3 volts ac, 4.8 amperes floating at -200 volts, when operating 219C. Connector mates with AMPHENOL "Blue Ribbon" connector, #26-4200-16S. |

## CONTENTS

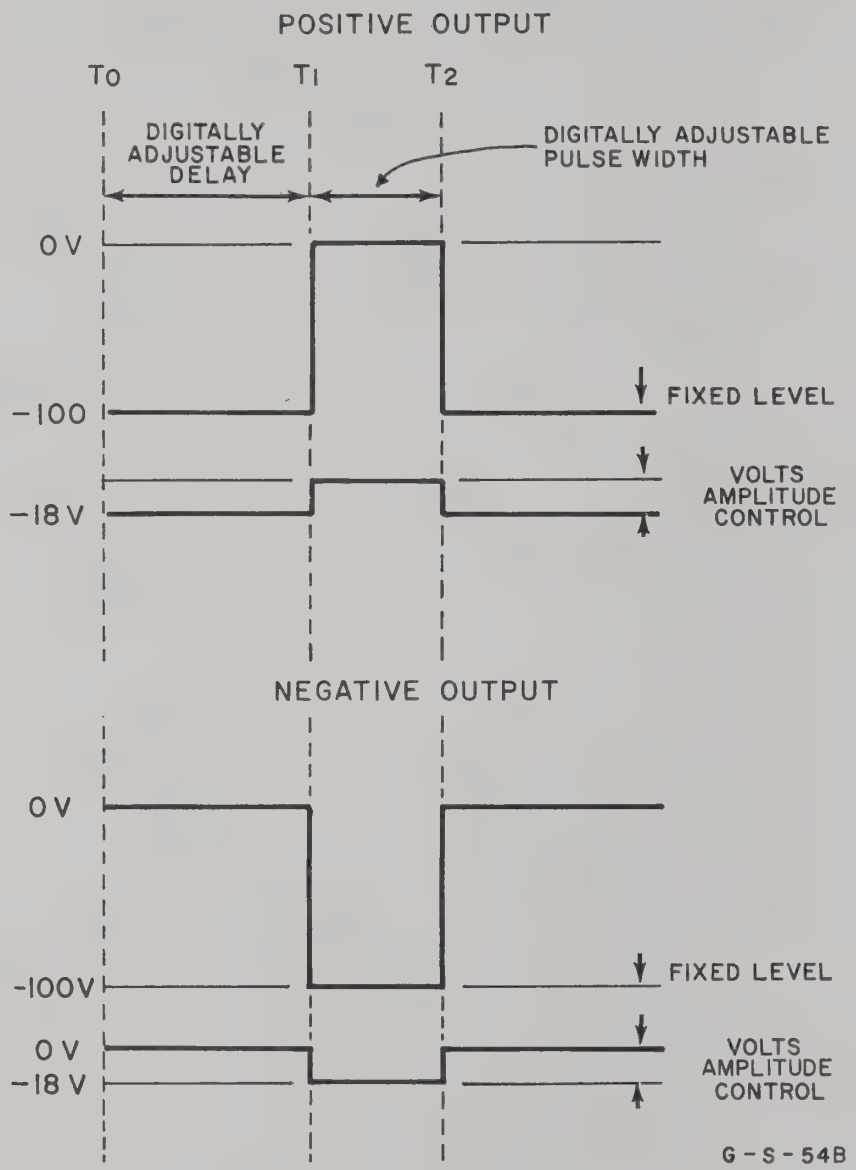



Figure 1-1. Digital Pulse Duration Unit Output Characteristics

# SECTION I
# GENERAL INFORMATION

## 1-1 INTRODUCTION

The hp Model 219C plug-in unit operates in conjunction with the Digital Delay Generator 218A. The unit delivers two concurrent output pulses of opposite polarity. The time delay setting of the Model 218A ($T_1$ and $T_2$) determine the beginning and the end of the pulse. In mode $T_0$ - $T_1$ the pulse duration is digitally controlled with the pulse starting at $T_0$ and ending at $T_1$. In mode $T_1$ - $T_2$ the pulse is digitally delayed until $T_1$. The pulse duration is digitally controlled with the pulse starting at $T_1$ and ending at $T_2$.

The output impedance of the two pulses is individually selectable. With output switch in position 90 Ω the output pulse amplitude is 18 volts nominal (into open circuit). With switch in position 500Ω the output pulse amplitude is 100 volts nominal (into open circuit).

The fast rise and decay time of the output pulse (better than 0.03 μsec) combined with the high output power make the 219C plug-in unit useful for pulsing radar, other microwave systems, gating circuits, etc.

## 1-2 CONNECTION TO MODEL 218A

All connections of the hp Model 219C Pulse Duration Generator to the hp Model 218A are made through a plug-jack combination by inserting the 219C into the opening provided in the 218A.

## 1-3 219C AS SEPARATE PULSE GENERATOR

The 219C Pulse Duration Generator can be operated as an independent pulse generator, by supplying externally trigger pulses, marking the beginning and the end of the duration of the output pulse. Most available laboratory power supplies are able to provide the necessary ac- and dc voltages. The mating plug necessary for these external connections is listed in Section V, Table of Replaceable Parts.

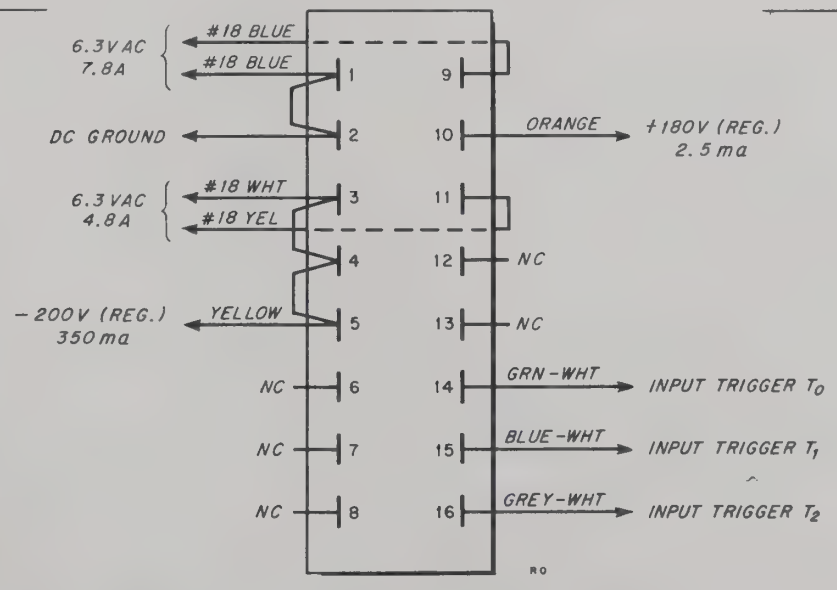
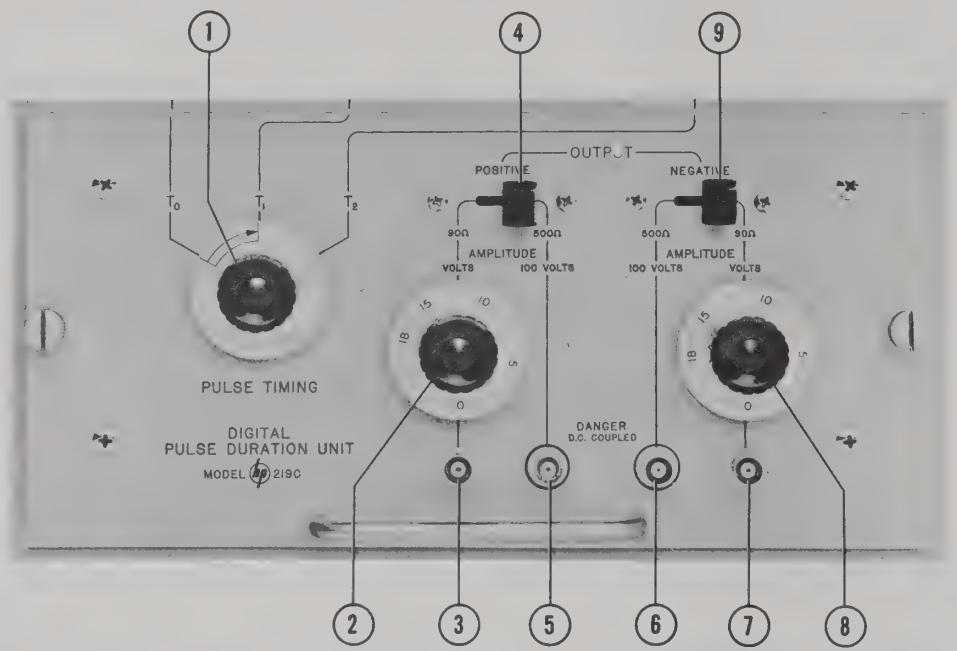



Figure 1-2. Connections to External Supply

## 219C OPERATING PROCEDURE




1. Select PULSE TIMING, indicating the time of the leading and trailing edge of the output pulse. If time sequence is reversed (i.e. if in position $T_1$-$T_2$ the time $T_2$ occurs before time $T_1$) the polarity of the output pulse will be reversed.
2. Select AMPLITUDE of positive, 90 ohm output pulse.
3. Output of POSITIVE PULSE, 90 ohm source impedance.
4. Select source impedance of POSITIVE PULSE, 90 ohm or 500 ohms.
5. Output of POSITIVE PULSE, 500 ohm source impedance.
6. Output of NEGATIVE PULSE, 500 ohm source impedance.
7. Output of NEGATIVE PULSE, 90 ohm source impedance.
8. Select AMPLITUDE of negative, 90 ohm output pulse.
9. Select source impedance of NEGATIVE PULSE, 90 ohm or 500 ohm.

Figure 2-1.

# SECTION II
# OPERATION

## 2-1 OPERATING PROCEDURES

The operating procedures given below supplement those given in the 218A Operating and Servicing Manual. The function of the various controls and switches is explained in Figure 2-1.

## 2-2 DC-COUPLED OUTPUT

CAUTION: Both 500-ohm outputs (positive and negative) are dc coupled at a level of -100 volts. A positive-going pulse starts at approximately -90 to -100 volts and reaches 0 volt at its peak value (open circuit voltage). The negative-going pulse starts at 0 volt and reaches -90 volts minimum (open circuit voltage) at its peak.

NOTE

The 0 volt level of both output pulses is obtained by cutting off the corresponding power amplifier tubes. Even with the tubes in cutoff, there is still a small current flowing which develops a voltage across the common load resistor (500 ohms) of approximately 1 volt maximum.

In applications where the output of the 219C is dc coupled (gating circuit, etc.) this fact has to be taken into consideration.

---

## 2-3 APPLICATION

A number of applications for the Model 218A and its companion plug-in units are discussed in the 218A Operating and Servicing Manual.

The fast rise and decay time of the output pulse (within 0.03 $\mu$sec) and the possibility to digitally time the duration of the pulse, make the 219C an ideal source for precisely timed gating pulses.

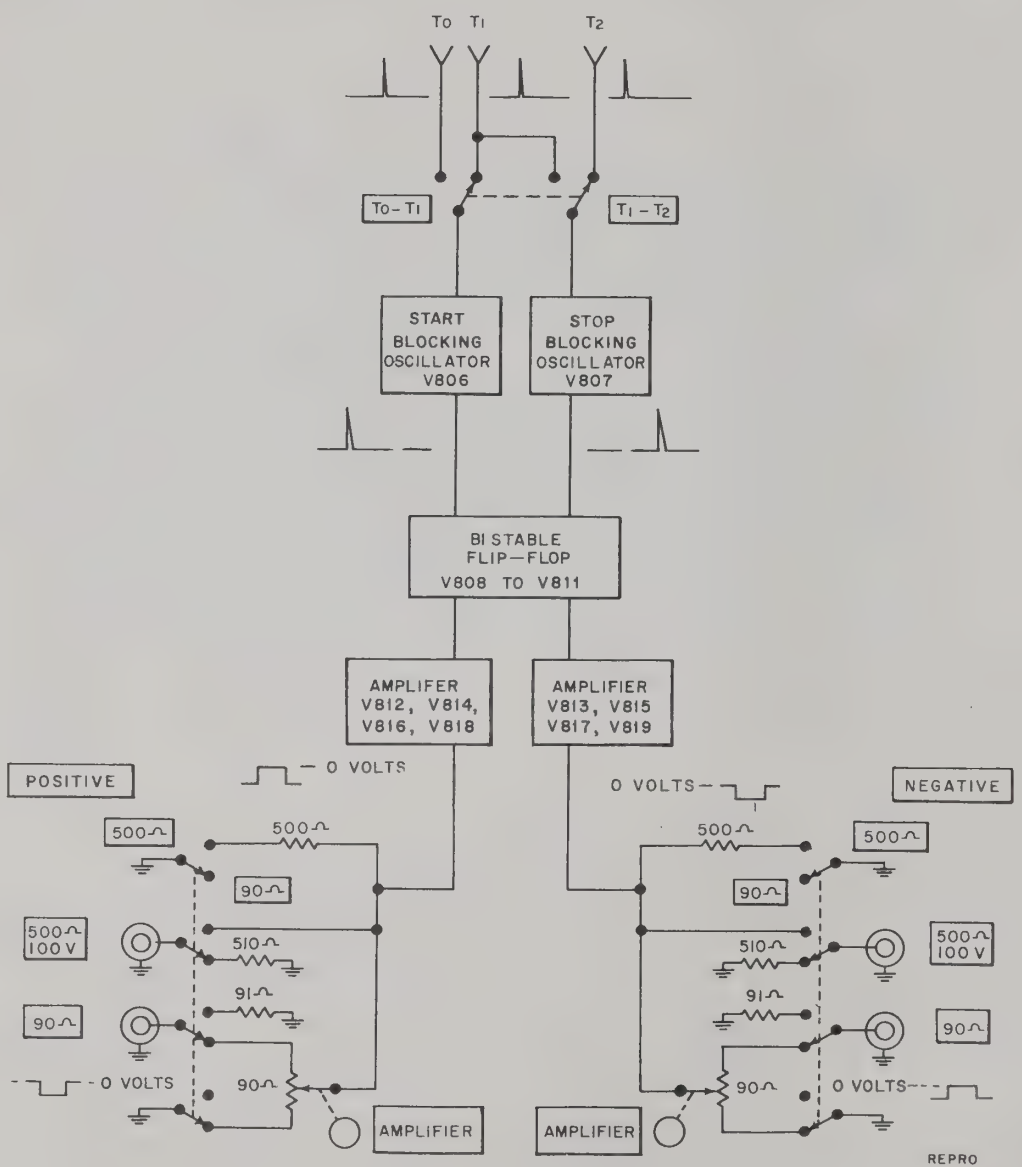



Figure 3-1. Block Diagram Model 219C

# SECTION III
# THEORY OF OPERATION

## 3-1 BLOCK DIAGRAM

The main part of the 219C unit is a bistable multivibrator (Flip-Flop) with the start and stop time digitally controlled by trigger pulses of the 218A. Figure 3-1 shows the complete block diagram of the 219C. There are two identical input sections (disregarding the time difference of the two trigger pulses) and two identical output sections (disregarding the polarity of the output pulses).

## 3-2 CIRCUIT DESCRIPTION

The complete circuit diagram of the 219C is shown in Figure 4-5. The description that follows refers also to the simplified block diagram of Figure 3-2.

Pulse timing switch S801 selects the start and stop timing of the output pulse. Assume switch S801 in position $T_1$ - $T_2$. Before start-trigger pulse $T_1$ triggers blocking oscillator V806, tubes V809 and

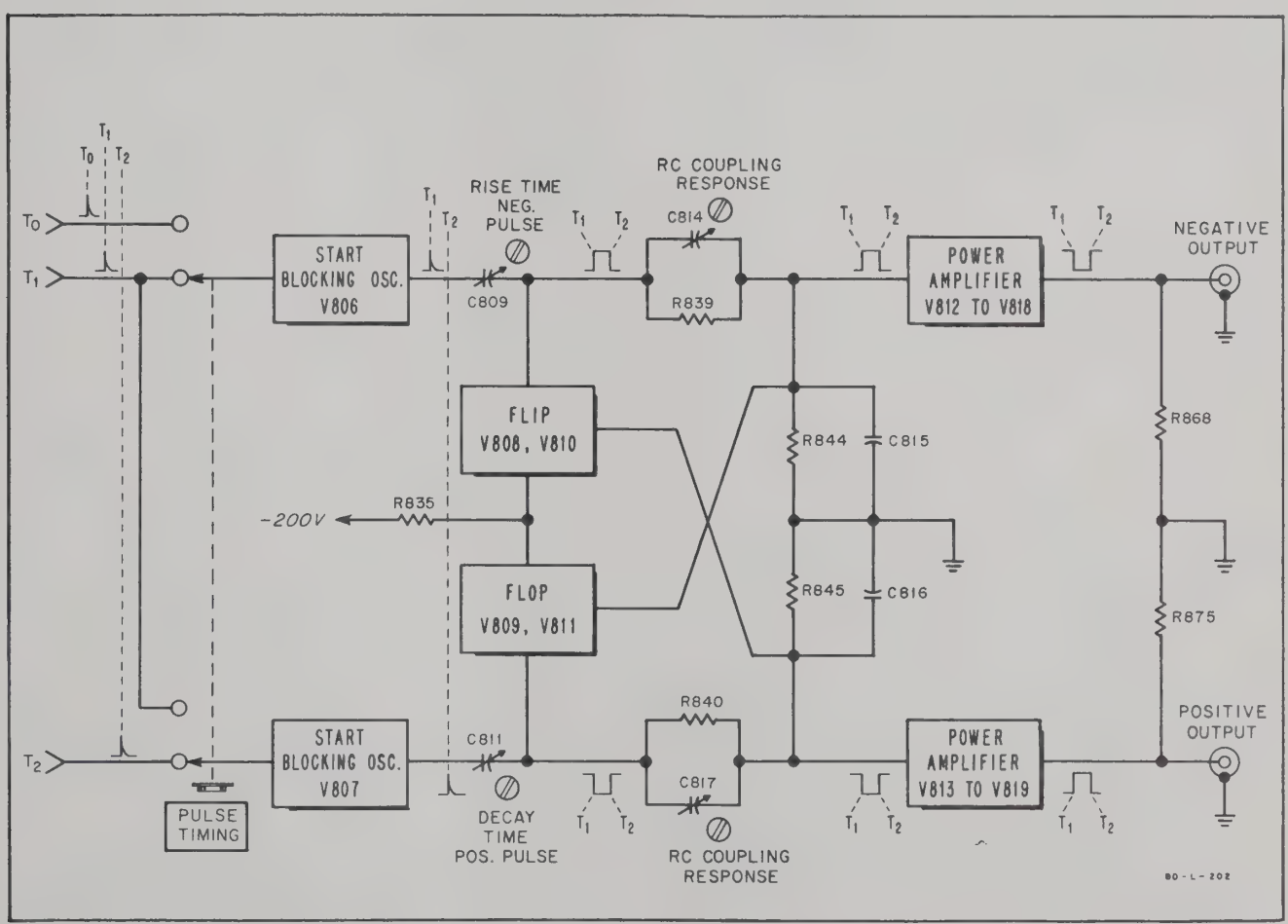



Figure 3-2. Simplified Block Diagram

V811 of the bistable multivibrator (Flip-Flop) are cut off where as V808 and V810 are conducting. At the output of V806 the trigger pulse $T_1$ appears amplified with improved rise time. The trigger pulse passes through diode CR801 and RC-coupling section (R839, C814 and C820) driving V809 and V811 into conduction. The voltage drop of plate 6 of V809 and V811 is coupled through the RC-coupling section (R840, C817 and C821) to V808 and V810, putting the two tubes into cutoff. Plate 6 of V808 and V810 rise sharply, thus providing the beginning of the positive driving pulse of the output amplifier (V812, V814, V816 and V818 operating in parallel). The end of the positive driving pulse is initiated by the stop trigger pulse $T_2$, supplied by the stop blocking oscillator V807 at $T_2$. Stop trigger pulse $T_2$ drives tube V808 and V810 into conduction. The voltage drop of plate 6 of V808 and V810 is coupled to V809 and V811, cutting the two tubes off.

The POSITIVE (NEGATIVE) output of the multivibrator is amplified (four tubes operating in parallel). The output of this power amplifier stage delivers 200 ma short circuit current. With switch in position 500 Ω the source impedance is 500 ohms and the open circuit voltage -100 volts nominal. In position 90 Ω the output impedance is 90 ohms and the open circuit voltage variable from 0-18 volts nominal. The output jacks not used are terminated in their characteristic impedance.

The rise time of the leading edge of the negative output pulse is controlled by capacitor C809. Capacitor C811 controls the trailing edge of the positive output pulse. C820 and C821 are adjusted for a flat RC-coupling response (see Figure 3-2).

It can be seen, that if start trigger pulse $T_1$ occurs after stop trigger pulse $T_2$ (selected time delay $T_1$ longer than delay time $T_2$) the polarity of the output pulses will be reversed.

## 3-3 POWER SUPPLY REGULATOR

Five additional series regulator tubes are located on the 219C circuit board. They are operated by a control signal from the -200 volt regulated supply and thus increase the available current of the -200 volt supply. Additional current is needed primarily for the power amplifier tubes in the 219C.

# SECTION IV
# MAINTENANCE

## 4-1 INTRODUCTION

This section contains information for servicing and adjusting the 219C Digital Pulse Duration Unit.

## 4-2 TEST EQUIPMENT

The following test equipment is needed to service the 219C:

1) High Frequency Oscilloscope, frequency response dc-30 mc such as Tektronix 541/545.

2) DC Vacuum Tube Voltmeter, with at least 100 megohm input impedance. Accuracy ±1 volt. Ⓗ Model 412A or equivalent.

## 4-3 ADJUSTMENTS

The 219C Digital Pulse Duration Unit requires four trimmer adjustments for proper operation.

The first two adjustments set the capacity compensation of the RC-coupling network connecting the output of the multivibrator to the input of the power amplifier.

The second two adjustments set the rise time of the leading edge of the positive output pulse and the trailing edge of the negative output pulse.

NOTE

For definition of pulse terms see Model 218A Operating and Servicing Manual, Section III.

---

Instrument Setup for Adjustments

All four adjustments are done with the same measurement setup as shown in Figure 4-2. For the settings of the various controls see also Fig. 4-1.

A. ADJUSTING FOR MINIMUM PULSE DROOP

Minimum pulse droop is obtained, by adjusting C817 and C814 for a flat base line, as indicated by Table 4-1, steps A and B. Set repetition rate and time delays as indicated, and observe output pulse on oscilloscope (use 90 ohm output, terminated with 90 ohms oscilloscope dc coupled).

B. ADJUSTMENT OF RISE AND DECAY TIME

Capacitor C809 is adjusted for maximum rise time without overshoot of the negative output pulse. The residual dip following the leading edge is due to the finite switching time of the Flip-Flop stage, and cannot be compensated completely (Table 4-1 step C).

Capacitor C811 is adjusted for maximum decay time without overshoot of the positive output pulse. Again there will be a residual dip, following the trailing edge, which cannot be compensated completely due to the finite switching time of the Flip-Flop stage (Table 4-1 step D).

## 4-4 TROUBLE SHOOTING

The 219C unit is most conveniently checked for troubles by using the signal tracing method. There are two identical input and output circuits disregarding the polarity of the output pulse.

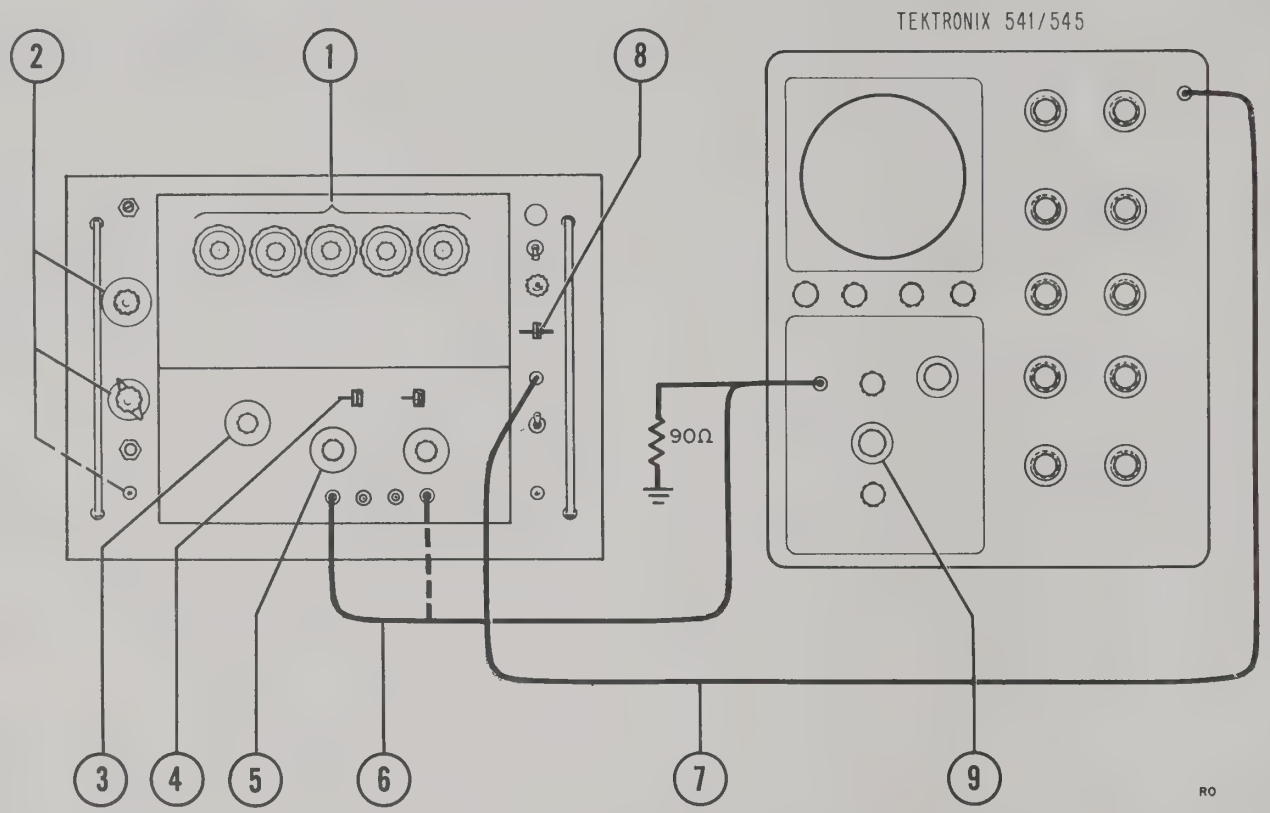
The trouble localization chart of Figure 4-2 leads systematically through the circuit, indicating the approximate signal amplitude and referring to components possibly causing the trouble symptom.

For trouble shooting of the 219C use setup of Figure 4-1 with the following alterations:

(1) Set $T_1$ to 0001.0 μsec and $T_2$ to 0003.0 μsec.

(8) Set selector switch to $T_0$.

## MEASUREMENT SETUP FOR ADJUSTMENTS




1. Select delay time $T_1$ and $T_2$.
2. Set Repetition Rate (internal or external).
3. Select PULSE TIMING.
4. Select OUTPUT IMPEDANCE for POSITIVE (NEGATIVE) OUTPUT pulse.
5. Select AMPLITUDE of POSITIVE (NEGATIVE OUTPUT pulse.
6. Connect 90 Ω OUTPUT with 90 ohm cable (terminated in 90 ohms) to VERTICAL INPUT of oscilloscope.
7. Connect SYNC OUTPUT of 218A to EXT. SYNC. INPUT of oscilloscope.
8. Set SYNC OUTPUT selector to $T_0$.
9. Set VERTICAL INPUT SENSITIVITY to 10 volts/cm.

Figure 4-1

(9) Set SWEEP TIME to 1 μsec/cm.

(5) Connect oscilloscope probe to VERTICAL INPUT and check the points indicated on Fig. 4-2.

The chart Figure 4-2 is read as follows:

1) Start in upper left corner. Perform check as indicated in box.

2) If check proves positive proceed to the right and perform next check.

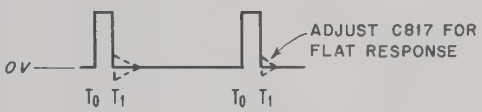
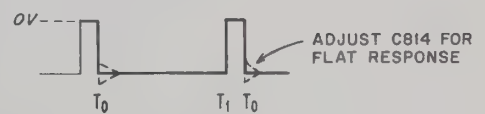
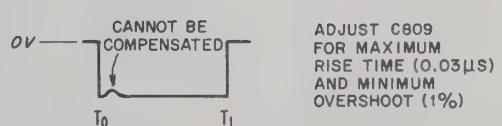
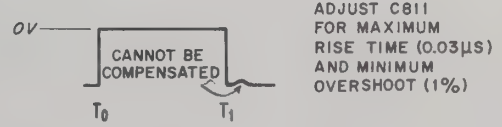
3) If check proves negative proceed downward and perform check as outlined in box.

4) When trouble symptom has been removed, recheck initial check (here check 1) and then proceed to the right.

Diode Replacement:

Replacement of diodes is not critical. Observe polarity and correct diode type when making a replacement. The diodes are color coded and identified as shown:


TABLE 4-1. ADJUSTMENT PROCEDURE FOR 219C

| Step | 218A Setting | Observe | Waveform |
|---|---|---|---|
| A | Frequency = 1000 cps<br>$T_1$ and $T_2$ = 100.0 μsec<br>Pulse Timing: $T_0$ - $T_1$<br>Sync: $T_0$<br>Sweep: 500 μsec/cm | Positive output pulse 90 ohms terminated with 90 ohms |  |
| B | Frequency = 100 cps<br>$T_1$ and $T_2$ = 2000 μsec<br>Pulse Timing: $T_0$ - $T_1$<br>Sync: $T_0$<br>Sweep: 500 μsec/cm | Negative output pulse 90 ohms terminated with 90 ohms |  |
| C | Frequency = 10,000 cps<br>$T_1$ and $T_2$ = 1 μsec<br>Pulse Timing: $T_0$ - $T_1$<br>Sync: $T_0$<br>Sweep: 0.5 μsec/cm | Negative output pulse 90 ohms terminated with 90 ohms |  |
| D | Frequency = 10,000 cps<br>$T_1$ and $T_2$ = 1 μsec<br>Pulse Timing: $T_0$ - $T_1$<br>Sync: $T_0$<br>Sweep: 0.5 μsec/cm | Positive output pulse 90 ohms terminated with 90 ohms |  |

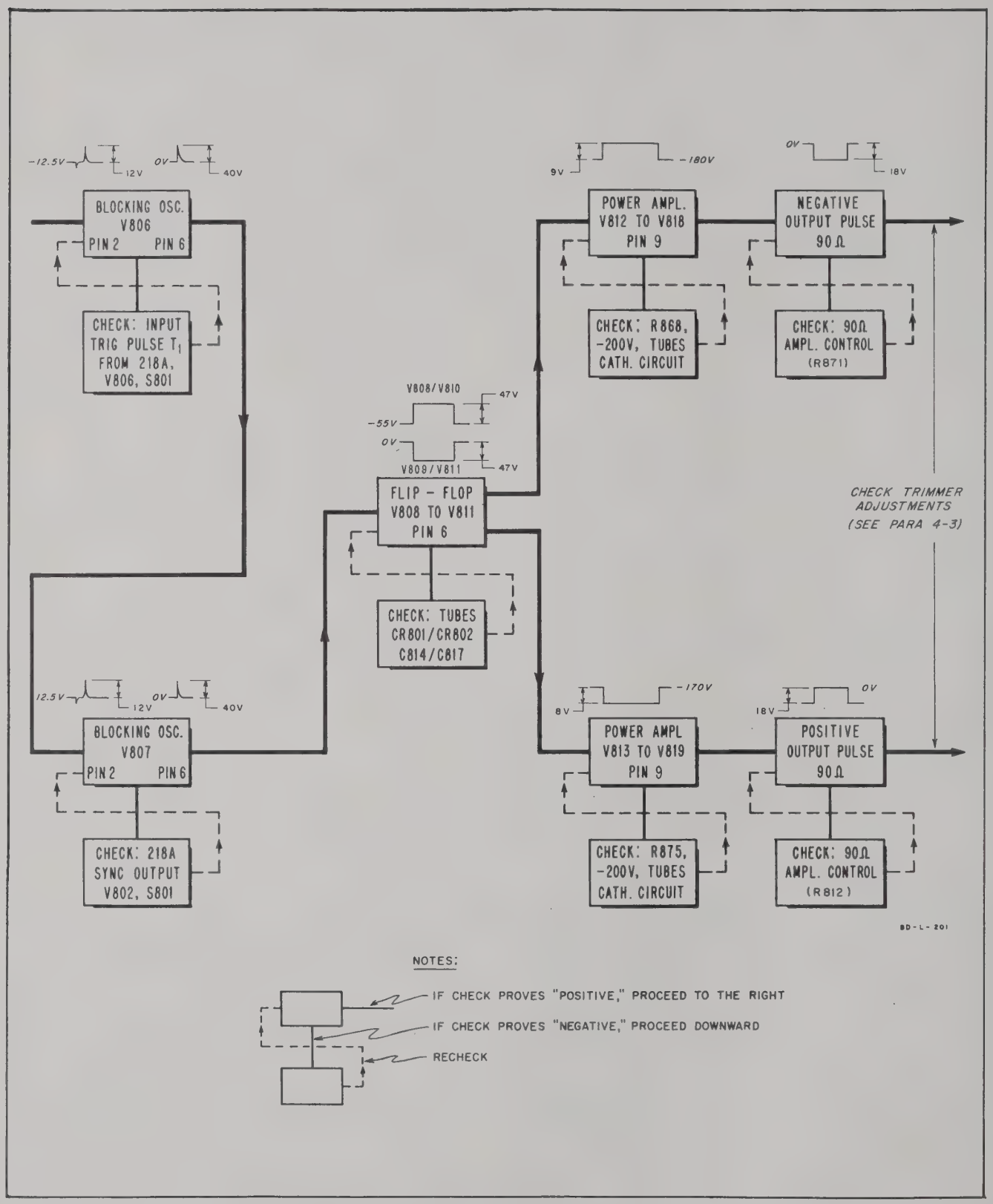



Figure 4-2. Trouble Localization Chart

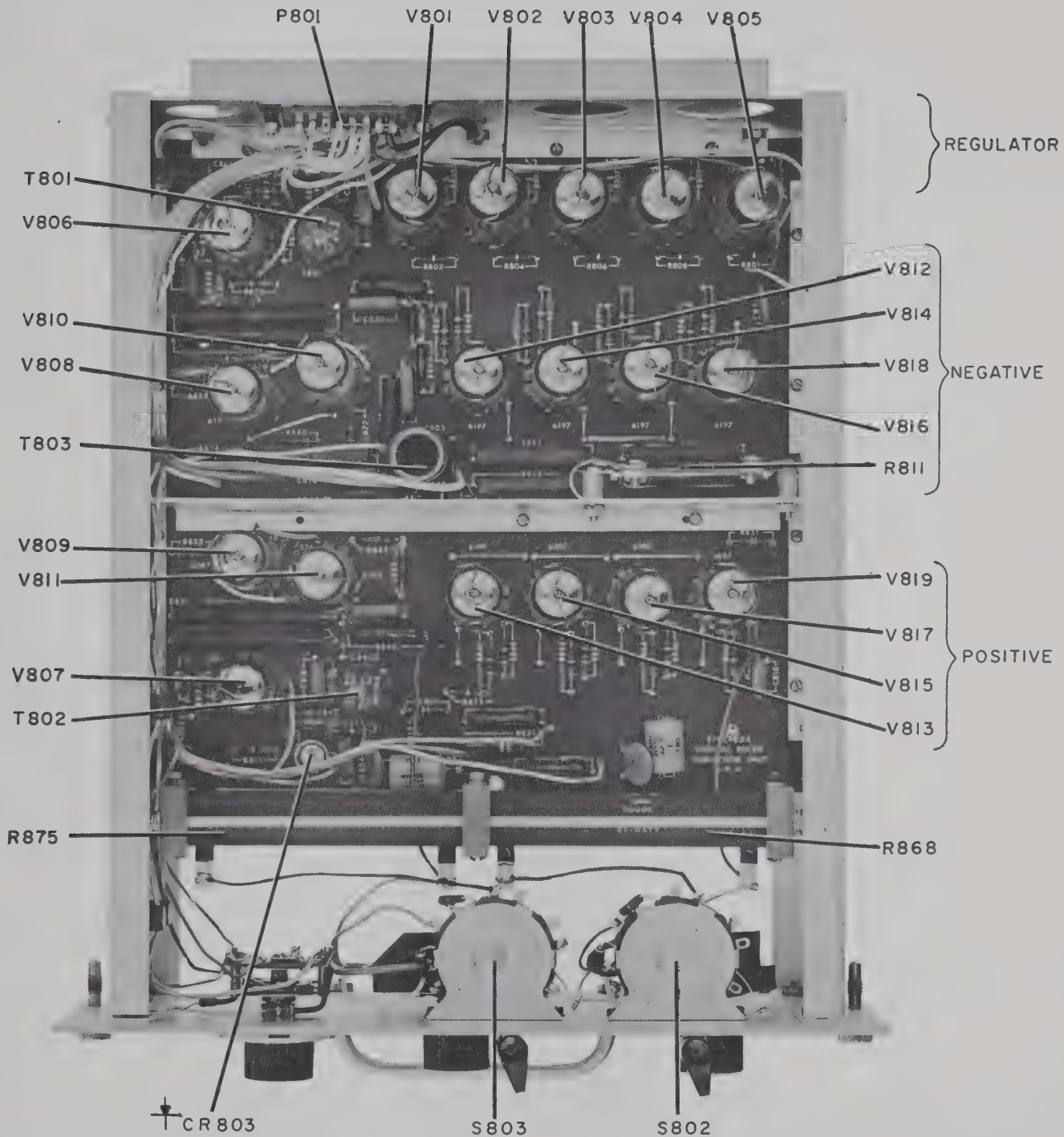



Figure 4-3. Top View of Model 219C

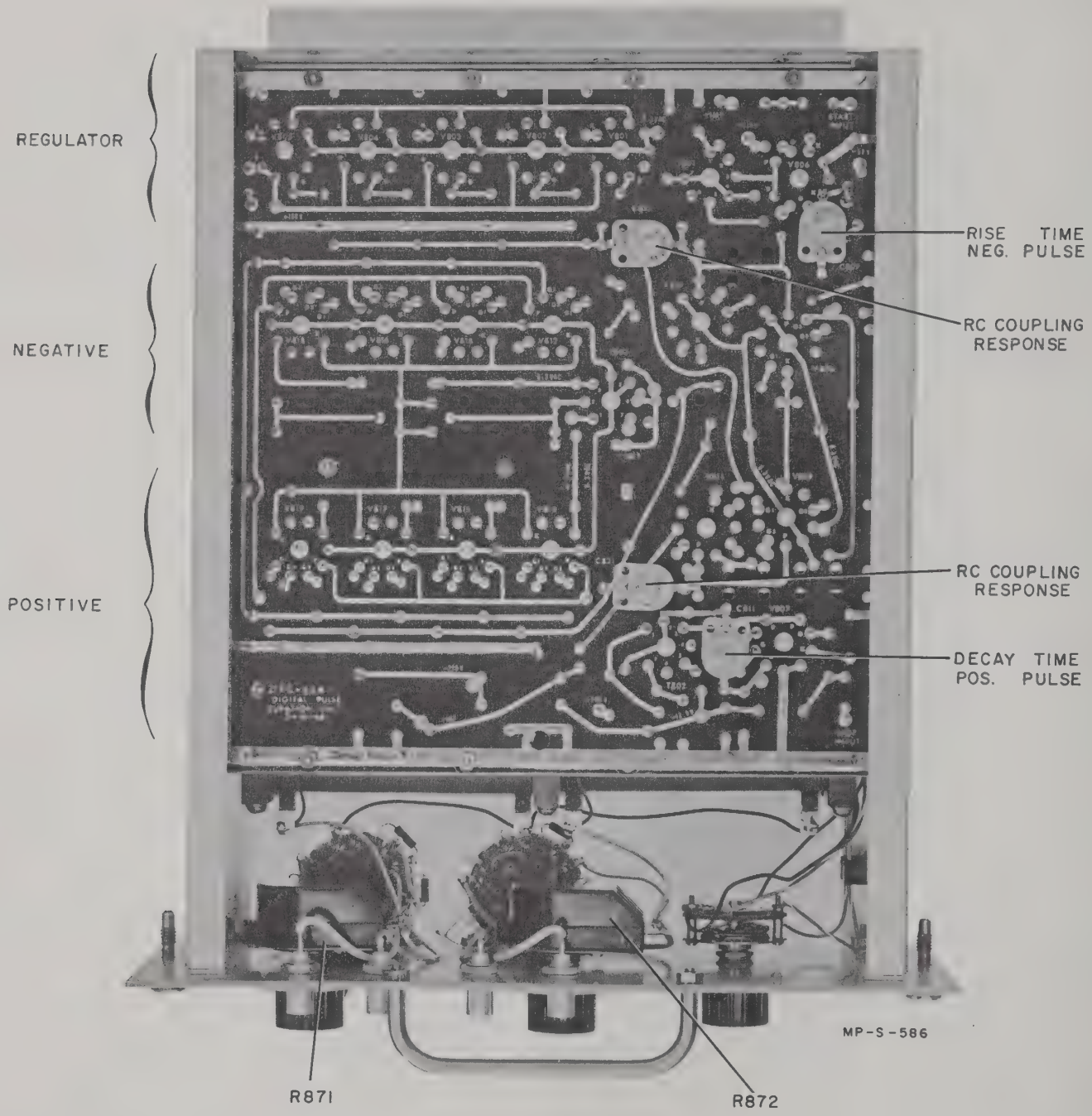



Figure 4-4. Bottom View of Model 219C

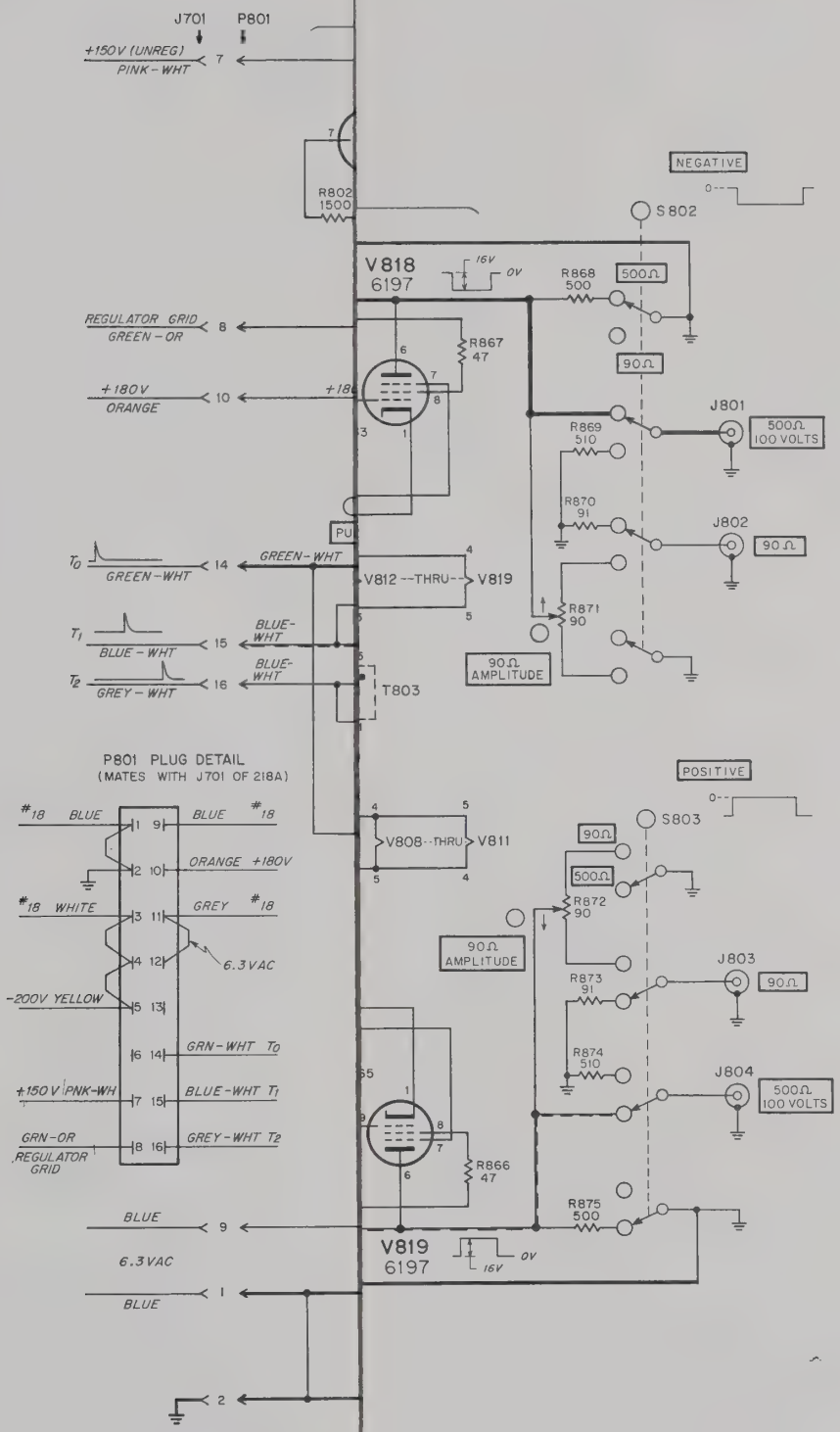



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Figure 4-5. Model 219C Digital Pulse Duration

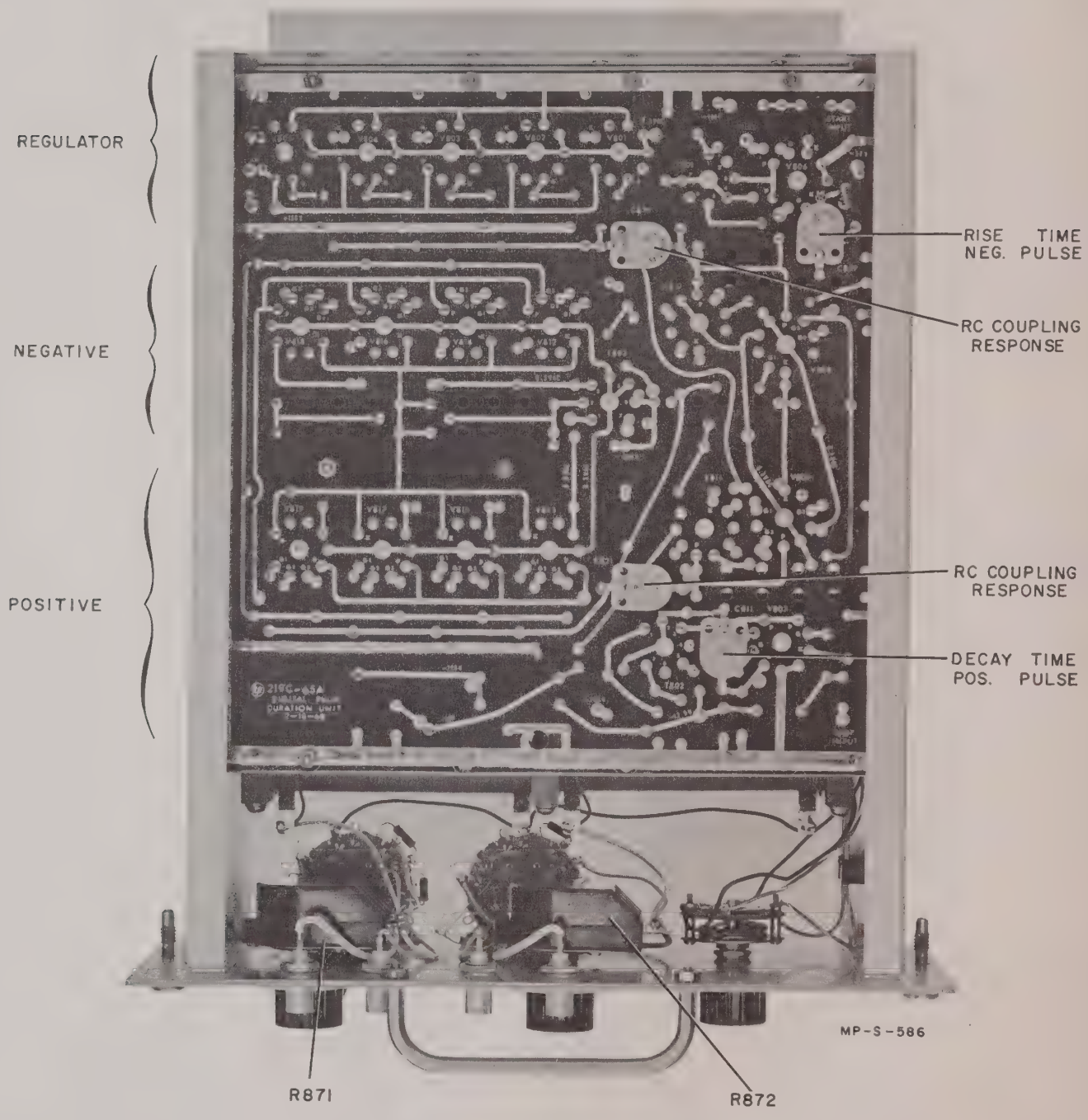


Figure 4-4. Bottom View of Model 219C

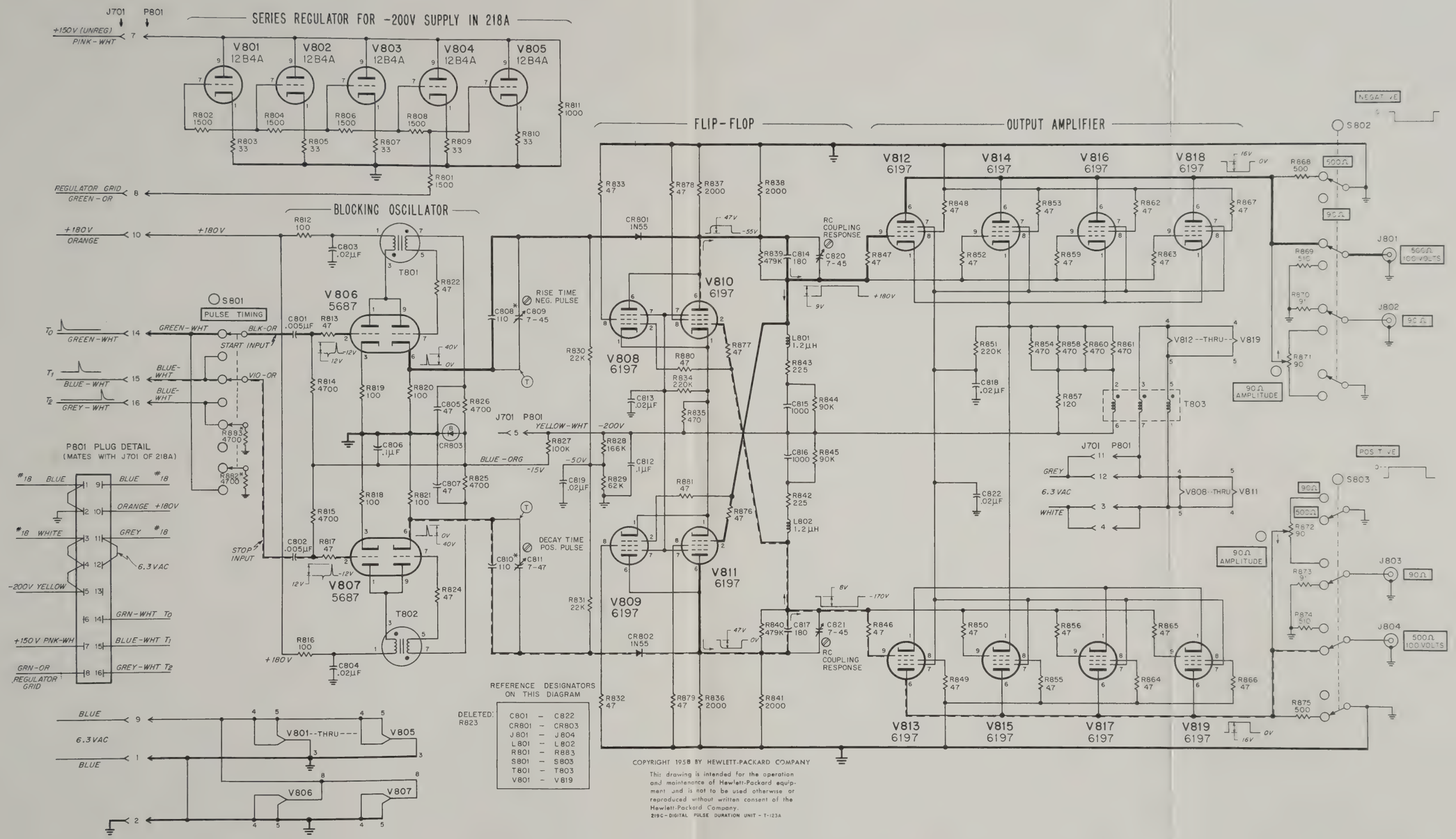


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Figure 4-5. Model 219C Digital Pulse Duration

# SECTION V
# REPLACEABLE PARTS

## 5-1 INTRODUCTION

This section contains information for ordering replacement parts for the 219C Pulse Duration Generator.

Table 5-1 lists replaceable parts in alpha-numerical order of their reference designators. Detailed information on a part used more than once in the instrument is listed opposite the first reference designator applying to the part. Other reference designators applying to the same part refer to the initial designator. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

1) Reference designator.

2) Full description of the part.

3) Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

4) Hewlett-Packard stock number.

5) Total quantity used in the instrument (TQ col).

6) Recommended spare quantity for complete maintenance during one year of isolated service (RS col).

## 5-2 ORDERING INFORMATION

To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S. A.
Rue du Vieux Billard No. 1
Geneva, Switzerland

Specify the following information for each part:

1) Model and complete serial number of instrument.

2) Hewlett-Packard stock number.

3) Circuit reference designator.

4) Description.

To order a part not listed in table 5-1, give a complete description of the part and include its function and location.

Table 5-1. Replaceable Parts

| Ckt Ref | Description | Mfr | ℗ Stock No. | TQ | RS | | |
|---|---|---|---|---|---|---|---|
| C1 thru C800 | Not assigned | | | | | | |
| C801, 802 | Capacitor: fixed, ceramic, 0.005 μf, 500 vdcw | 96095 | 0150-0014 | 2 | 1 | | |
| C803, 804 | Capacitor: fixed, ceramic, 0.02 μf + 80 -20%, 600 vdcw | 91418 | 0150-0024 | 6 | 2 | | |
| C805 | Capacitor: fixed, mica, 47 pf ±5%, 500 vdcw | 76433 | 0140-0039 | 2 | 1 | | |
| C806 | Capacitor: fixed, mylar, 0.1 μf ±20%, 600 vdcw | 09134 | 0170-0022 | 2 | 1 | | |

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| C807 | Same as C805 | | | | | | |
| C808 | Capacitor: fixed, mica, 110 pf ±5%, 500 vdcw Optimum value selected at factory Average value shown | 76433 | 0140-0036 | 2 | 1 | | |
| C809 | Capacitor: variable, ceramic, 7-45 pf, 500 vdcw | 72982 | 0130-0001 | 4 | 1 | | |
| C810 | Same as C808 | | | | | | |
| C811 | Same as C809 | | | | | | |
| C812 | Same as C806 | | | | | | |
| C813 | Same as C803 | | | | | | |
| C814 | Capacitor: fixed, mica, 180 pf ±10%, 500 vdcw | 00853 | 0140-0023 | 2 | 1 | | |
| C815, 816 | Capacitor: fixed, mica, 0.001 pf ±1%, 500 vdcw | 00853 | 0140-0099 | 2 | 1 | | |
| C817 | Same as C814 | | | | | | |
| C818, 819 | Same as C803 | | | | | | |
| C820, 821 | Same as C809 | | | | | | |
| C822 | Same as C803 | | | | | | |
| CR1 thru CR800 | Not assigned | | | | | | |
| CR801, 802 | Diode, germanium: 1N55A | 08792 | 1910-0003 | 2 | 2 | | |
| CR803 | Diode, breakdown | 28480 | G-31G-15H | 1 | 1 | | |
| J1 thru J800 | Not assigned | | | | | | |
| J801 thru J804 | Connector, female: BNC, type UG1094/U | 91737 | 1250-0083 | 4 | 1 | | |
| L1 thru L800 | Not assigned | | | | | | |
| L801, 802 | Inductor: 1.2 μh ±10%, 4 W | 99848 | 9140-0046 | 2 | 1 | | |
| P1 thru P800 | Not assigned | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| P801 | Connector, male: 16 pin | 02660 | 1251-0006 | 1 | 1 | | |
| R1 thru R800 | Not assigned | | | | | | |
| R801, 802 | Resistor: fixed, composition, 1500 ohms ± 10%, 1/2 W | 01121 | 0687-1521 | 5 | 2 | | |
| R803 | Resistor: fixed, composition, 33 ohms ± 10%, 1/2 W | 01121 | 0687-3301 | 5 | 2 | | |
| R804 | Same as R801 | | | | | | |
| R805 | Same as R803 | | | | | | |
| R806 | Same as R801 | | | | | | |
| R807 | Same as R803 | | | | | | |
| R808 | Same as R801 | | | | | | |
| R809, 810 | Same as R803 | | | | | | |
| R811 | Resistor: fixed, wirewound, 1000 ohms ± 5%, 40 W | 94310 | 0818-0014 | 1 | 1 | | |
| R812 | Resistor: fixed, composition, 100 ohms ± 10%, 1/2 W | 01121 | 0687-1011 | 6 | 2 | | |
| R813 | Resistor: fixed, composition, 47 ohms ± 10%, 1/2 W | 01121 | 0687-4701 | 28 | 6 | | |
| R814, 815 | Resistor: fixed, composition, 4700 ohms ± 10%, 1/2 W | 01121 | 0687-4721 | 6 | 2 | | |
| R816 | Same as R812 | | | | | | |
| R817 | Same as R813 | | | | | | |
| R818 thru R821 | Same as R812 | | | | | | |
| R822 | Same as R813 | | | | | | |
| R823 | Not assigned | | | | | | |
| R824 | Same as R813 | | | | | | |
| R825, | Same as R814 | | | | | | |
| R827 | Resistor: fixed, composition, 100, 000 ohms ± 10%, 1 W Optimum value selected at factory. Average value shown. | 01121 | 0690-1041 | 1 | 1 | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R828 | Resistor: fixed, deposited carbon, 166,000 ohms ± 1%, 1 W | 19701 | 0730-0076 | 1 | 1 | | |
| R829 | Resistor: fixed, deposited carbon, 62,000 ohms ± 1%, 1 W | 19701 | 0730-0055 | 1 | 1 | | |
| R830, 831 | Resistor: fixed, composition, 22,000 ohms ± 10%, 1/2 W | 01121 | 0687-2231 | 2 | 1 | | |
| R832, 833 | Same as R813 | | | | | | |
| R834 | Resistor: fixed, composition, 220,000 ohms ± 10%, 1/2 W | 01121 | 0687-2241 | 2 | 1 | | |
| R835 | Resistor: fixed, metal film, 470 ohms ± 10%, 4 W | 07115 | 0771-0002 | 5 | 2 | | |
| R836 thru R838 | Resistor: fixed, metal film, 2000 ohms ± 1%, 2 W | 07115 | 0763-0001 | 4 | 1 | | |
| R839, 840 | Resistor: fixed, deposited carbon, 479,000 ohms ± 1%, 1 W | 19701 | 0730-0091 | 2 | 1 | | |
| R841 | Same as R836 | | | | | | |
| R842, 843 | Resistor: fixed, deposited carbon, 225 ohms ± 1%, 1/2 W | 19701 | 0727-0060 | 2 | 1 | | |
| R844, 845 | Resistor: fixed, deposited carbon, 90,000 ohms ± 1%, 1 W | 19701 | 0730-0064 | 2 | 1 | | |
| R846 thru R850 | Same as R813 | | | | | | |
| R851 | Same as R834 | | | | | | |
| R852, 853 | Same as R813 | | | | | | |
| R854 | Same as R835 | | | | | | |
| R855, 856 | Same as R813 | | | | | | |
| R857 | Resistor: fixed, composition, 120 ohms ± 10%, 1 W | 01121 | 0690-1211 | 1 | 1 | | |
| R858 | Same as R835 | | | | | | |
| R859 | Same as R813 | | | | | | |
| R860, 861 | Same as R835 | | | | | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| R862 thru R867 | Same as R813 | | | | | | |
| R868 | Resistor: fixed, metal film, 500 ohms ±2%, 25 W | 07115 | 0778-0001 | 2 | 1 | | |
| R869 | Resistor: fixed, composition, 510 ohms ±5%, 1/2 W | 01121 | 0686-5115 | 2 | 1 | | |
| R870 | Resistor: fixed, composition, 91 ohms ±5%, 1/2 W | 01121 | 0686-9105 | 2 | 1 | | |
| R871, 872 | Resistor: variable, composition, linear taper, 90 ohms ±10%, 5 W | 01121 | 2100-0176 | 2 | 1 | | |
| R873 | Same as R870 | | | | | | |
| R874 | Same as R869 | | | | | | |
| R875 | Same as R868 | | | | | | |
| R876 thru R881 | Same as R813 | | | | | | |
| R882, 883 | Same as R814<br>Optimum value selected at factory<br>Average value shown | | | | | | |
| S1 thru S800 | Not assigned | | | | | | |
| S801 | Switch, rotary: DPDT, 2 position, 1 section | 76854 | 3100-0177 | 1 | 1 | | |
| S802, 803 | Switch, lever: 5 pole, 2 position, | 37942 | 3100-0176 | 2 | 1 | | |
| T1 thru T800 | Not assigned | | | | | | |
| T801, 802 | Transformer, pulse | 28480 | 219B-60B | 2 | 1 | | |
| T803A, B, C | Transformer, trifilar wound | 28480 | 211A-60A | 1 | 1 | | |
| V1 thru V800 | Not assigned | | | | | | |
| V801 thru V805 | Tube, electron: 12B4A | 80131 | 1921-0010 | 5 | 5 | | |
| V806, 807 | Tube, electron: 7119 or 5687 | 80131 | 1932-0016<br>1932-0002 | 2 | 2 | | |

* See introduction to this section

Table 5-1. Replaceable Parts (Cont'd)

| Ckt Ref | Description | Mfr * | ℗ Stock No. | TQ* | RS* | | |
|---|---|---|---|---|---|---|---|
| V803 thru V819 | Tube, electron: 6197 | 80131 | 1923-0005 | 12 | 12 | | |
| | MISCELLANEOUS | | | | | | |
| | Knob: AMPLITUDE PULSE TIMING | 80131 | G-74H | 2 | 0 | | |
| | Knob: POSITIVE OUTPUT<br>NEGATIVE OUTPUT | 80131 | G-74AA | 2 | 0 | | |
| | Screw, captive | 95264 | 0570-0032 | 2 | 0 | | |

* See introduction to this section

# APPENDIX
## CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

| CODE NO. | MANUFACTURER | ADDRESS |
|---|---|---|
| 00334 | Humidial Co. | Colton, Calif. |
| 00335 | Westrex Corp. | New York, N.Y. |
| 00373 | Garlock Packing Co., Electronic Products Div. | Camden, N.J. |
| 00656 | Aerovox Corp. | New Bedford, Mass. |
| 00779 | Amp, Inc. | Harrisburg, Pa. |
| 00781 | Aircraft Radio Corp. | Boonton, N.J. |
| 00853 | Sangamo Electric Co., Cap. Div. | Marion, Ill. |
| 00866 | Goe Engineering Co. | Los Angeles, Calif. |
| 00891 | Carl E. Holmes Corp. | Los Angeles, Calif. |
| 01121 | Allen Bradley Co. | Milwaukee, Wis. |
| 01255 | Litton Industries, Inc. | Beverly Hills, Calif. |
| 01281 | Pacific Semiconductors, Inc. | Culver City, Calif. |
| 01295 | Texas Instruments, Inc. Semiconductor Components Div. | Dallas, Texas |
| 01349 | The Alliance Mfg. Co. | Alliance, Ohio |
| 01561 | Chassi-Trak Corp. | Indianapolis, Ind. |
| 01961 | Pulse Engineering Co. | Santa Clara, Calif. |
| 02114 | Ferroxcube Corp. of America | Saugerties, N.Y. |
| 02286 | Cole Mfg. Co. | Palo Alto, Calif. |
| 02660 | Amphenol Electronics Corp. | Chicago, Ill. |
| 02735 | Radio Corp. of America Semiconductor and Materials Div. | Somerville, N.J. |
| 02777 | Hopkins Engineering Co. | San Fernando, Calif. |
| 03508 | G.E. Semiconductor Products Dept. | Syracuse, N.Y. |
| 03705 | Apex Machine & Tool Co. | Dayton, Ohio |
| 03797 | Eldema Corp. | El Monte, Calif. |
| 03877 | Transitron Electronic Corp. | Wakefield, Mass. |
| 03954 | Air Marine Motors, Inc. | Los Angeles, Calif. |
| 04009 | Arrow, Hart and Hegeman Elect. Co. | Hartford, Conn. |
| 04062 | Elmenco Products Co. | New York, N.Y. |
| 04222 | Hi-Q Division of Aerovox | Myrtle Beach, S.C. |
| 04651 | Special Tube Operations of Sylvania Electronic Systems | Mountain View, Calif. |
| 04713 | Motorola, Inc., Semiconductor Prod. Div. | Phoenix, Arizona |
| 04732 | Filtron Co., Inc. Western Division | Culver City, Calif. |
| 04777 | Automatic Electric Sales Corp. | Northlake, Ill. |
| 05006 | Twentieth Century Plastics, Inc. | Los Angeles, Calif. |
| 05277 | Westinghouse Electric Corp., Semi-Conductor Dept. | Youngwood, Pa. |
| 05593 | Illumitronic Engineering Co. | Sunnyvale, Calif. |
| 05624 | Barber Colman Co. | Rockford, Ill. |
| 05783 | Stewart Engineering Co. | Soquel, Calif. |
| 06004 | The Bassick Co. | Bridgeport, Conn. |
| 06812 | Torrington Mfg. Co., West. Div. | Van Nuys, Calif. |
| 07115 | Corning Glass Works Electronic Components Dept. | Bradford, Pa. |
| 07126 | Digitran Co. | Pasadena, Calif. |
| 07137 | Transistor Electronics Corp. | Minneapolis, Minn. |
| 07138 | Westinghouse Electric Corp. Electronic Tube Div. | Elmira, N.Y. |
| 07261 | Avnet Corp. | Los Angeles, Calif. |
| 07263 | Fairchild Semiconductor Corp. | Mountain View, Calif. |
| 07933 | Rheem Semiconductor Corp. | Mountain View, Calif. |
| 07980 | Boonton Radio Corp. | Boonton, N.J. |
| 08145 | U.S. Engineering Co. | Los Angeles, Calif. |
| 08358 | Burgess Battery Co. | Niagara Falls, Ontario, Canada |
| 08717 | Sloan Company | Burbank, Calif. |
| 08718 | Cannon Electric Co. Phoenix Div. | Phoenix, Ariz. |
| 08792 | CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc. | Lowell, Mass. |
| 09134 | Texas Capacitor Co. | Houston, Texas |
| 09250 | Electro Assemblies, Inc. | Chicago, Ill. |
| 09569 | Mallory Battery Co. of Canada, Ltd. | Toronto, Ontario, Canada |
| 10411 | Ti-Tal, Inc. | Berkeley, Calif. |
| 10646 | Carborundum Co. | Niagara Falls, N.Y. |
| 11236 | CTS of Berne, Inc. | Berne, Ind. |
| 11237 | Chicago Telephone of California, Inc. | So. Pasadena, Calif. |
| 11264 | Dymec, Inc. | Palo Alto, Calif. |
| 12697 | Clarostat Mfg. Co. | Dover, N.H. |
| 14655 | Cornell Dubilier Elec. Corp. | So. Plainfield, N.J. |
| 15909 | The Daven Co. | Livingston, N.J. |
| 16758 | Delco Radio Div. of G. M. Corp. | Kokomo, Ind. |
| 18873 | E. I. DuPont and Co., Inc. | Wilmington, Del. |
| 19315 | Eclipse Pioneer, Div. of Bendix Aviation Corp. | Teterboro, N.J. |
| 19500 | Thomas A. Edison Industries, Div. of McGraw-Edison Co. | West Orange, N.J. |
| 19701 | Electra Manufacturing Co. | Kansas City, Mo. |
| 20183 | Electronic Tube Corp. | Philadelphia, Pa. |
| 21520 | Fansteel Metallurgical Corp. | No. Chicago, Ill. |
| 21335 | The Fafnir Bearing Co. | New Britain, Conn. |
| 21964 | Fed. Telephone and Radio Corp. | Clifton, N.J. |
| 24446 | General Electric Co. | Schenectady, N.Y. |
| 24455 | G. E., Lamp Division | Nela Park, Cleveland, Ohio |
| 24655 | General Radio Co. | West Concord, Mass. |
| 26462 | Grobet File Co. of America, Inc. | Carlstadt, N.J. |
| 26992 | Hamilton Watch Co. | Lancaster, Pa. |
| 28480 | Hewlett-Packard Co. | Palo Alto, Calif. |
| 33173 | G. E. Receiving Tube Dept. | Owensboro, Ky. |
| 35434 | Lectrohm Inc. | Chicago, Ill. |
| 37942 | P. R. Mallory & Co., Inc. | Indianapolis, Ind. |
| 39543 | Mechanical Industries Prod. Co. | Akron, Ohio |
| 40920 | Miniature Precision Bearings, Inc. | Keene, N.H. |
| 42190 | Muter Co. | Chicago, Ill. |
| 43990 | C. A. Norgren Co. | Englewood, Colo. |
| 44655 | Ohmite Mfg. Co. | Skokie, Ill. |
| 47904 | Polaroid Corp. | Cambridge, Mass. |
| 48620 | Precision Thermometer and Inst. Co. | Philadelphia, Pa. |
| 49956 | Raytheon Mfg. Co. | Waltham, Mass. |
| 54294 | Shallcross Mfg. Co. | Selma, N.C. |
| 55026 | Simpson Electric Co. | Chicago, Ill. |
| 55933 | Sonotone Corp. | Elmsford, N.Y. |
| 55938 | Sorenson & Co., Inc. | So. Norwalk, Conn. |
| 56137 | Spaulding Fibre Co., Inc. | Tonawanda, N.Y. |
| 56289 | Sprague Electric Co. | North Adams, Mass. |
| 59446 | Telex, Inc. | St. Paul, Minn. |
| 61775 | Union Switch and Signal, Div. of Westinghouse Air Brake Co. | Pittsburgh, Pa. |
| 62119 | Universal Electric Co. | Owosso, Mich. |
| 64959 | Western Electric Co., Inc. | New York, N.Y. |
| 65092 | Weston Inst. Div. of Daystrom, Inc. | Newark, N.J. |
| 66346 | Wollensak Optical Co. | Rochester, N.Y. |
| 70119 | Advance Electric and Relay Co. | Burbank, Calif. |
| 70276 | Allen Mfg. Co. | Hartford, Conn. |
| 70309 | Allied Control Co., Inc. | New York, N.Y. |
| 70485 | Atlantic India Rubber Works, Inc. | Chicago, Ill. |
| 70563 | Amperite Co., Inc | New York, N.Y. |
| 70903 | Belden Mfg. Co. | Chicago, Ill. |
| 70998 | Bird Electronic Corp. | Cleveland, Ohio |
| 71002 | Birnbach Radio Co. | New York, N.Y. |
| 71218 | Bud Radio Inc. | Cleveland, Ohio |
| 71286 | Camloc Fastener Corp. | Paramus, N.J. |
| 71313 | Allen D. Cardwell Electronic Prod. Corp | Plainville, Conn. |
| 71400 | Bussmann Fuse Div. of McGraw-Edison Co. | St. Louis, Mo. |
| 71450 | CTS Corp. | Elkhart, Ind. |
| 71468 | Cannon Electric Co. | Los Angeles, Calif. |
| 71471 | Cinema Engineering Co. | Burbank, Calif. |
| 71482 | C. P. Clare & Co. | Chicago, Ill. |
| 71590 | Centralab Div. of Globe Union Inc. | Milwaukee, Wis. |
| 71700 | The Cornish Wire Co. | New York, N.Y. |
| 71744 | Chicago Miniature Lamp Works | Chicago, Ill. |
| 71753 | A. O. Smith Corp., Crowley Div. | West Orange, N.J. |
| 71785 | Cinch Mfg. Corp. | Chicago, Ill. |
| 71984 | Dow Corning Corp. | Midland, Mich. |
| 72136 | Electro Motive Mfg. Co., Inc. | Willimantic, Conn. |
| 72354 | John E. Fast & Co. | Chicago, Ill. |
| 72619 | Dialight Corp. | Brooklyn, N.Y. |
| 72656 | General Ceramics Corp. | Keasbey, N.J. |
| 72758 | Girard-Hopkins | Oakland, Calif. |
| 72765 | Drake Mfg. Co. | Chicago, Ill. |
| 72825 | Hugh H. Eby Inc. | Philadelphia, Pa. |
| 72928 | Gudeman Co. | Chicago, Ill. |
| 72982 | Erie Resistor Corp. | Erie, Pa. |
| 73061 | Hansen Mfg. Co., Inc. | Princeton, Ind. |
| 73138 | Helipot Div. of Beckman Instruments, Inc. | Fullerton, Calif. |
| 73293 | Hughes Products Div. of Hughes Aircraft Co. | Newport Beach, Calif. |
| 73445 | Amperex Electronic Co., Div. of North American Phillips Co., Inc. | Hicksville, N.Y. |
| 73506 | Bradley Semiconductor Corp. | New Haven, Conn. |
| 73559 | Carling Electric, Inc. | Hartford, Conn. |
| 73682 | George K. Garrett Co., Inc. | Philadelphia, Pa. |
| 73743 | Fischer Special Mfg. Co. | Cincinnati, Ohio |
| 73793 | The General Industries Co. | Elyria, Ohio |
| 73905 | Jennings Radio Mfg. Co. | San Jose, Calif. |
| 74455 | J. H. Winns, and Sons | Winchester, Mass. |
| 74861 | Industrial Condenser Corp. | Chicago, Ill. |
| 74868 | Industrial Products Co. | Danbury, Conn. |
| 74970 | E. F. Johnson Co. | Waseca, Minn. |
| 75042 | International Resistance Co. | Philadelphia, Pa. |
| 75173 | Jones, Howard B., Division of Cinch Mfg. Corp. | Chicago, Ill. |
| 75378 | James Knights Co. | Sandwich, Ill. |
| 75382 | Kulka Electric Mfg. Co., Inc. | Mt. Vernon, N.Y. |
| 75818 | Lenz Electric Mfg. Co. | Chicago, Ill. |
| 75915 | Littelfuse Inc. | Des Plaines, Ill. |

# APPENDIX
## CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

| CODE NO. | MANUFACTURER | ADDRESS |
|---|---|---|
| 76005 | Lord Mfg. Co. | Erie, Pa. |
| 76210 | C. W. Marwedel | San Francisco, Calif. |
| 76433 | Micamold Electronic Mfg. Corp. | Brooklyn, N.Y. |
| 76487 | James Millen Mfg. Co., Inc. | Malden, Mass. |
| 76530 | Monadnock Mills | San Leandro, Calif. |
| 76545 | Mueller Electric Co. | Cleveland, Ohio |
| 76854 | Oak Manufacturing Co. | Chicago, Ill. |
| 77068 | Bendix Corp., Bendix Pacific Div. | No. Hollywood, Calif. |
| 77221 | Phaostron Instrument and Electronic Co. | South Pasadena, Calif. |
| 77342 | Potter and Brumfield, Inc. | Princeton, Ind. |
| 77630 | Radio Condenser Co. | Camden, N.J. |
| 77634 | Radio Essentials Inc. | Mt. Vernon, N.Y. |
| 77638 | Radio Receptor Co., Inc. | Brooklyn, N.Y. |
| 77764 | Resistance Products Co. | Harrisburg, Pa. |
| 78283 | Signal Indicator Corp. | New York, N.Y. |
| 78471 | Tilley Mfg. Co. | San Francisco, Calif. |
| 78488 | Stackpole Carbon Co. | St. Marys, Pa. |
| 78553 | Tinnerman Products, Inc. | Cleveland, Ohio |
| 78790 | Transformer Engineers | Pasadena, Calif. |
| 78947 | Ucinite Co. | Newtonville, Mass. |
| 79142 | Veeder Root, Inc. | Hartford, Conn. |
| 79251 | Wenco Mfg. Co. | Chicago, Ill. |
| 79963 | Zierick Mfg. Corp. | New Rochelle, N.Y. |
| 80031 | Mepco Division of Sessions Clock Co. | Morristown, N.J. |
| 80130 | Times Facsimile Corp. | New York, N.Y. |
| 80131 | Electronic Industries Association Any brand tube meeting EIA standards | Washington, D.C. |
| 80248 | Oxford Electric Corp. | Chicago, Ill. |
| 80411 | Acro Manufacturing Co. | Columbus, Ohio |
| 80486 | All Star Products Inc. | Defiance, Ohio |
| 80583 | Hammerlund Co., Inc. | New York, N.Y. |
| 80640 | Stevens, Arnold, Co., Inc. | Boston, Mass. |
| 81030 | International Instruments, Inc. | New Haven, Conn. |
| 81415 | Wilkor Products, Inc. | Cleveland, Ohio |
| 81453 | Raytheon Mfg. Co., Industrial Tube Division | Quincy, Mass. |
| 81483 | International Rectifier Corp. | El Segundo, Calif. |
| 81860 | Barry Controls, Inc. | Watertown, Mass. |
| 82042 | Carter Parts Co. | Skokie, Ill. |
| 82142 | Jeffers Electronics Division of Speer Carbon Co. | Du Bois, Pa. |
| 82170 | Allen B. DuMont Labs., Inc. | Clifton, N.J. |
| 82209 | Maguire Industries, Inc. | Greenwich, Conn. |
| 82219 | Sylvania Electric Prod. Inc., Electronic Tube Div. | Emporium, Pa. |
| 82376 | Astron Co. | East Newark, N.J. |
| 82389 | Switchcraft, Inc. | Chicago, Ill. |
| 82647 | Texas Instruments, Inc., Metals and Controls Div., Spencer Products | Attleboro, Mass. |
| 82866 | Research Products Corp. | Madison, Wis. |
| 82893 | Vector Electronic Co. | Glendale, Calif. |
| 83148 | Electro Cords Co. | Los Angeles, Calif. |
| 83186 | Victory Engineering Corp. | Union, N.J. |
| 83298 | Bendix Corp., Red Bank Div. | Red Bank, N.J. |
| 83594 | Burroughs Corp., Electronic Tube Div. | Plainfield, N.J. |
| 83777 | Model Eng. and Mfg., Inc. | Huntington, Ind. |
| 83821 | Loyd Scruggs Co. | Festus, Mo. |
| 84171 | Arco Electronics, Inc. | New York, N.Y. |
| 84396 | A. J. Glesener Co., Inc. | San Francisco, Calif. |
| 84411 | Good All Electric Mfg. Co. | Ogallala, Neb. |
| 84970 | Sarkes Tarzian, Inc. | Bloomington, Ind. |
| 85474 | R. M. Bracamonte & Co. | San Francisco, Calif. |
| 85660 | Koiled Kords, Inc. | New Haven, Conn. |
| 85911 | Seamless Rubber Co. | Chicago, Ill. |
| 86684 | Radio Corp. of America, RCA Electron Tube Div. | Harrison, N.J. |
| 87473 | Western Fibrous Glass Products Co. | San Francisco, Calif. |
| 88140 | Cutler-Hammer, Inc. | Lincoln, Ill. |
| 89473 | General Electric Distributing Corp. | Schenectady, N.Y. |
| 90179 | U.S. Rubber Co., Mechanical Goods Div. | Passaic, N.J. |
| 90970 | Bearing Engineering Co. | San Francisco, Calif. |
| 91418 | Radio Materials Co. | Chicago, Ill. |
| 91506 | Augat Brothers, Inc. | Attleboro, Mass. |
| 91637 | Dale Products, Inc. | Columbus, Neb. |
| 91662 | Elco Corp. | Philadelphia, Pa. |
| 91737 | Gremar Mfg. Co., Inc. | Wakefield, Mass. |
| 91827 | K F Development Co. | Redwood City, Calif. |
| 91929 | Micro-Switch Div. of Minneapolis Honeywell Regulator Co. | Freeport, Ill. |
| 92196 | Universal Metal Products, Inc. | Bassett Puente, Calif. |
| 93332 | Sylvania Electric Prod. Inc., Semiconductor Div. | Woburn, Mass. |
| 93369 | Robbins and Myers, Inc. | New York, N.Y. |
| 93410 | Stevens Mfg. Co., Inc. | Mansfield, Ohio |
| 93983 | Insuline-Van Norman Ind., Inc. Electronic Division | Manchester, N.H. |
| 94144 | Raytheon Mfg. Co., Receiving Tube Div. | Quincy, Mass. |
| 94145 | Raytheon Mfg. Co., Semiconductor Div. | Newton, Mass. |
| 94148 | Scientific Radio Products, Inc. | Loveland, Colo. |
| 94154 | Tung-Sol Electric, Inc. | Newark, N.J. |
| 94197 | Curtiss-Wright Corp., Electronics Div. | Carlstadt, N.J. |
| 94310 | Tru Ohm Prod. Div. of Model Engineering and Mfg. Co. | Chicago, Ill. |
| 95236 | Allies Products Corp. | Miami, Fla. |
| 95238 | Continental Connector Corp. | Woodside, N.Y. |
| 95263 | Leecraft Mfg. Co., Inc. | New York, N.Y. |
| 95264 | Lerco Electronics, Inc. | Burbank, Calif. |
| 95265 | National Coil Co. | Sheridan, Wyo. |
| 95354 | Methode Mfg. Co. | Chicago, Ill. |
| 95987 | Weckesser Co. | Chicago, Ill. |
| 96067 | Huggins Laboratories | Sunnyvale, Calif. |
| 96095 | Hi-Q Division of Aerovox | Olean, N.Y. |
| 96296 | Solar Manufacturing Co. | Los Angeles, Calif. |
| 96330 | Carlton Screw Co. | Chicago, Ill. |
| 96341 | Microwave Associates, Inc. | Burlington, Mass. |
| 96501 | Excel Transformer Co. | Oakland, Calif. |
| 97539 | Automatic and Precision Mfg. Co. | Yonkers, N.Y. |
| 97966 | CBS Electronics, Div. of C.B.S., Inc. | Danvers, Mass. |
| 98141 | Axel Brothers Inc. | Jamaica, N.Y. |
| 98220 | Francis L. Mosley | Pasadena, Calif. |
| 98278 | Microdot, Inc. | So. Pasadena, Calif. |
| 98291 | Sealectro Corp. | New Rochelle, N.Y. |
| 98405 | Carad Corp. | Redwood City, Calif. |
| 98734 | Palo Alto Engineering Co., Inc. | Palo Alto, Calif. |
| 98925 | Clevite Transistor Prod. Div. of Clevite Corp. | Waltham, Mass. |
| 98978 | International Electronic Research Corp. | Burbank, Calif. |
| 99109 | Columbia Technical Corp. | New York, N.Y. |
| 99313 | Varian Associates | Palo Alto, Calif. |
| 99515 | Marshall Industries, Electron Products Division | Pasadena, Calif. |
| 99707 | Control Switch Division, Controls Co. of America | El Segundo, Calif. |
| 99800 | Delevan Electronics Corp. | East Aurora, N.Y. |
| 99821 | North Hills Electric Co. | Great Neck, L.I., N.Y. |
| 99848 | Wilco Corporation | Indianapolis, Ind. |
| 99934 | Renbrandt, Inc. | Boston, Mass. |
| 99942 | Hoffman Semiconductor Div. of Hoffman Electronics, Corp. | Evanston, Ill. |
| 99957 | Technology Instruments Corp. of Calif. | No. Hollywood, Calif. |

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

| | | |
|---|---|---|
| 0000C | Connor Spring Mfg. Co. | San Francisco, Calif. |
| 0000D | Connex Corp. | Oakland, Calif. |
| 0000E | Fisher Switches, Inc. | San Francisco, Calif. |
| 0000F | Malco Tool and Die | Los Angeles, Calif. |
| 0000G | Microwave Engineering Co. | Palo Alto, Calif. |
| 0000H | Philco Corp. (Lansdale Division) | Lansdale, Pa. |
| 0000I | Telefunken (c/o American Elite) | New York, N.Y. |
| 0000L | Winchester Electronics, Inc. | Santa Monica, Calif. |
| 0000M | Western Coil Div. of Automatic Ind., Inc. | Redwood City, Calif. |
| 0000N | Nahm-Bros. Spring Co. | San Leandro, Calif. |
| 0000P | Ty-Car Mfg. Co., Inc. | Holliston, Mass. |
| 0000R | Metro Cap. Div., Metropolitan Telecommunications Corp. | Brooklyn, N.Y. |
| 0000S | Moulton Electronics | San Carlos, Calif. |
| 0000T | Texas Instruments, Inc. Metals and Controls Div. | Versailles, Ky. |
| 0000U | Tower Mfg. Corp. | Providence, R.I. |
| 0000V | Imperial Electronics, Inc. | Buena Park, Calif. |

From: F.S.C. Handbook Supplements
H4-1 Dated Oct. 1960
H4-2 Dated Jan. 1961

00015-12
Revised: 13 July 1961

## WARRANTY

*All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.*

For assistance of any kind, including help with instruments under warranty, contact your authorized hp Sales Representative for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

## CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

## SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

## GENERAL

Your authorized hp Sales Representative is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

**CUSTOMER SERVICE**

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, U.S.A.
Telephone: (415) 326-1755
TWX No. PAL AL 117-U
Cable: "HEWPACK"

**OR (In Western Europe)**

Hewlett-Packard S.A.
54-54bis Route Des Acacias
Geneva, Switzerland
Telephone: (022) 42. 81. 50
Cable: "HEWPACKSA"

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